May 23, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

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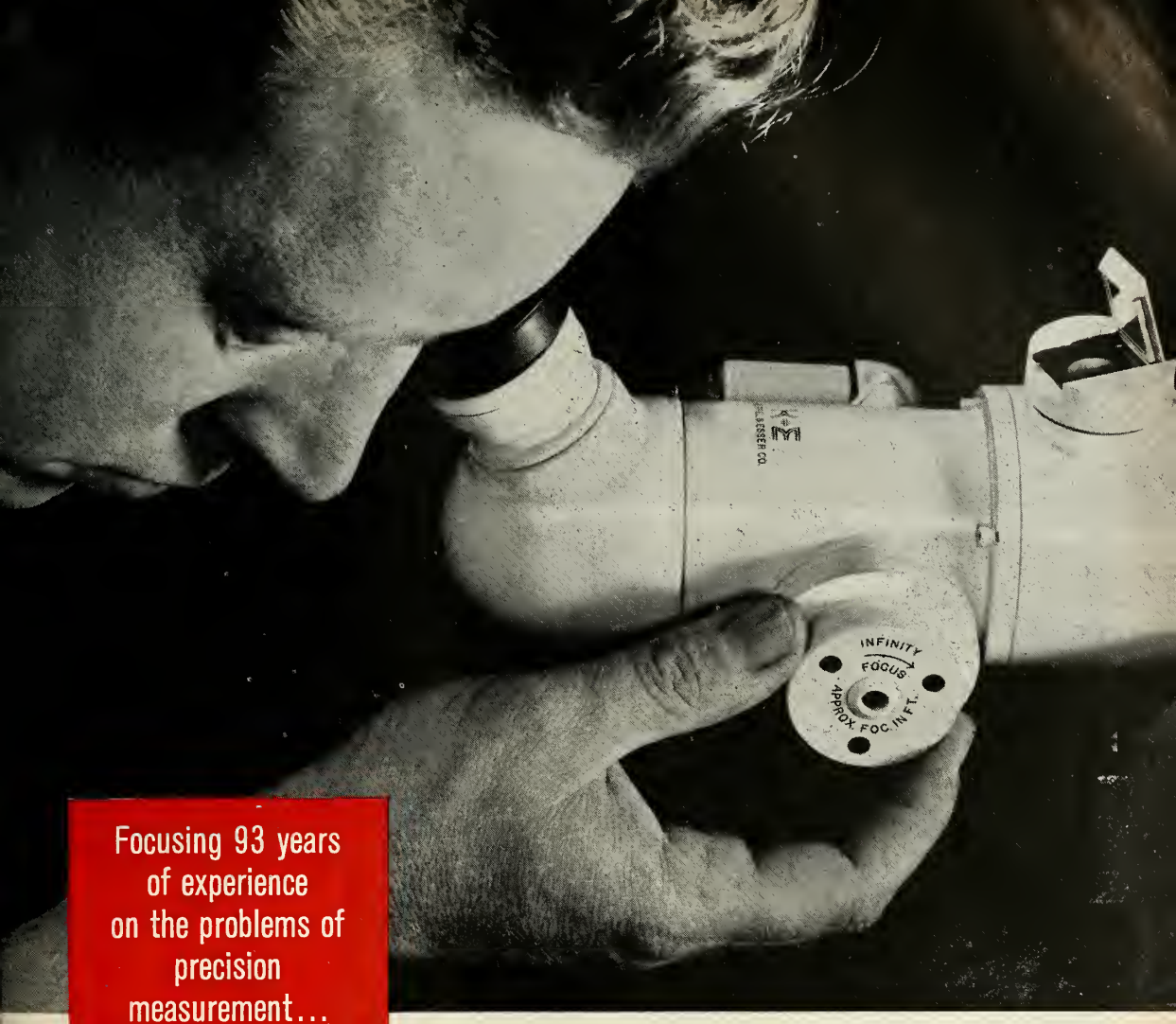

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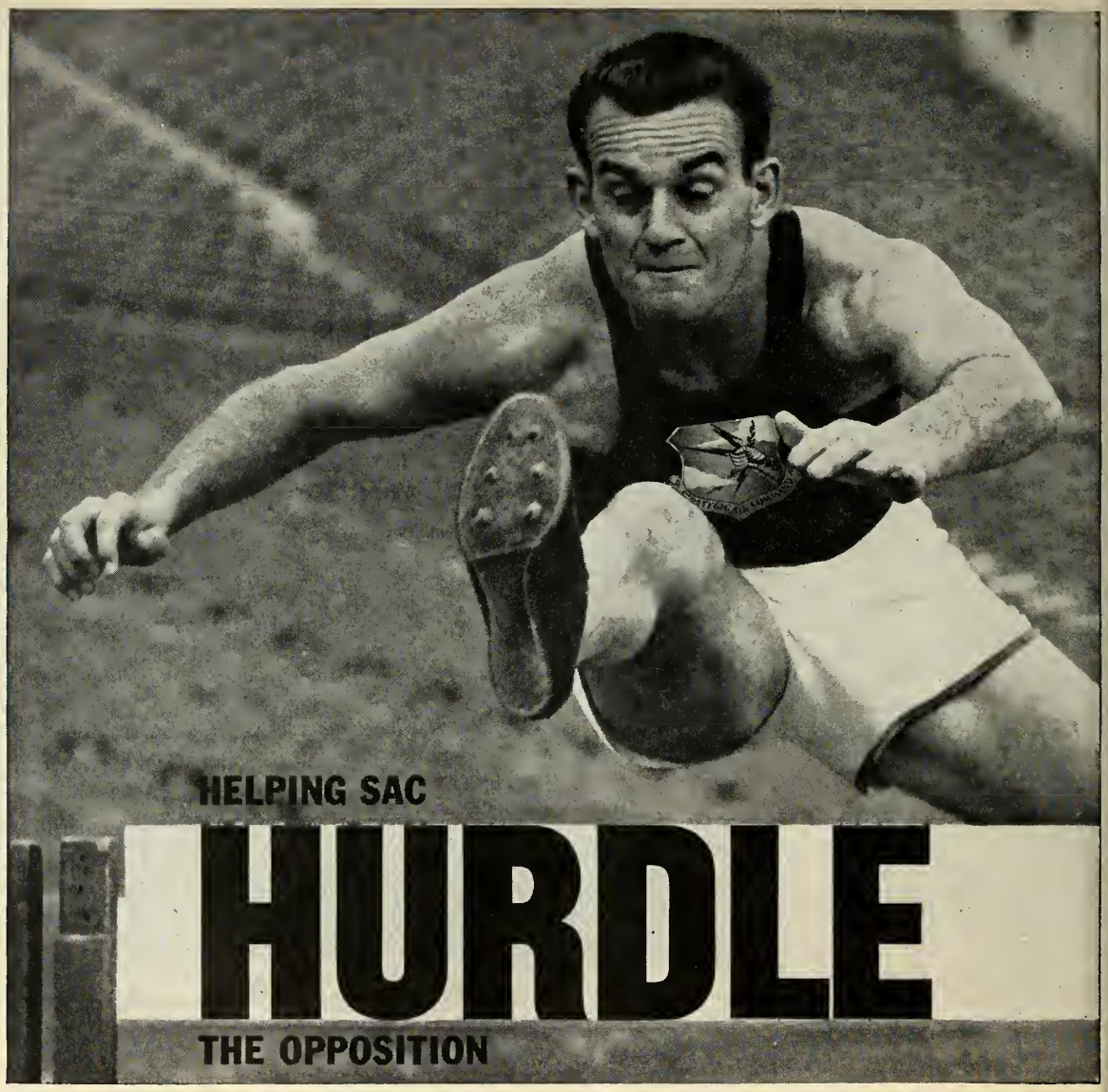

SAC is now off and running with its new Hound Dog missile. With the supersonic GAM-77 missile, the B-52 bomber can more easily hurdle ground defenses on the way to a target. In the short span of just 30 months, the Hound Dog air-to-surface missile grew from the drawing board to a powerful member of SAC's deterrent team.

Silencing enemy ground defense centers while the mother ship speeds on toward the main target is just one of the jobs of the versatile GAM-77 missile. Slung beneath the swept-back wings of a B-52, a pair of GAM-77's can either clear a path for the bomber, or be sent right in on the main target itself. This triple-threat capability lets a single B-52 command a target approach corridor over a thousand miles wide.

To further confuse the enemy, these inertially-guided missiles can feint at pseudo-targets before turning toward their real objectives. Speed and altitude variations can also be programmed into the GAM-77's target approach.

The Hound Dog missile greatly extends the useful life and striking power of SAC's B-52 bombers—the backbone of America's strategic power. The GAM-77 is being produced by the Missile Division of North American Aviation.

MISSILE DIVISION
NORTH AMERICAN AVIATION, INC.
Downey, California

THE MISSILE / SPACE WEEKLY

missiles and rockets

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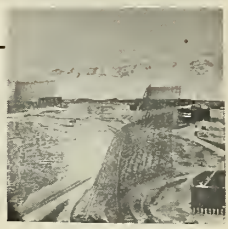


THE COVER

BMEWS antennas at Thule, Greenland, will radiate fans of multimillion-watt RF energy to detect ICBM's 3000 miles away. The site is nearing completion (see p. 36).

MAY 23 HEADLINES

ELECTRONICS

PROPULSION ENGINEERING

ADVANCED MATERIALS

HUMAN FACTORS

GROUND SUPPORT EQUIPMENT

ASW ENGINEERING

INTERNATIONAL

DEPARTMENTS

31,130 copies this issue

letters

Vehicle Recovery Coverage

To the Editor:

For the past two years I have read my copies of M/R from cover to cover and have thoroughly enjoyed each and every article.

A subject of prime interest to myself and various colleagues has not, however, been covered in past publications of your magazine.

The subject I refer to is re-entry vehicle recovery systems—in particular the parachute and flotation components of these systems.

I believe that information for an article of this nature might be available from General Electric's Missile and Space Vehicle Department, Space and Recovery Systems, Inc., El Segundo, Calif., and Col. J. Dodge, Director of Re-entry Vehicle Department, USAF.

Ellis W. Hartman, Jr.
Rutherford Heights, Pa.

M/R has already done some preliminary investigation of work in this area and, depending on developments, may carry a story about it in the near future. We appreciate the suggestion and expression of interest.—Ed.

Battery Clarification

To the Editor:

In the May 2, 1960 issue, reference is made to your article "Special Handling Demands are Basic to Launch Success" and, specifically, the part entitled Missile Subsystems. There are apparently some points which need clarification on the primary and secondary battery portions.

It is pointed out that exposure prior to launch of temperatures around 125°F would require special air conditioning equipment to keep the primary battery cool. This would not be necessary on exposures of less than one month at temperatures in the range of 125-130°F. In general the temperatures would not be at the high value continuously but only for short periods of time in cyclic fashion.

With reference to disposal of electrolyte overflow after battery activation, this must be peculiar to only one manufacturer. We are producing batteries for *Atlas, Titan,* various nose cones and other missiles, and most of the torpedoes, where there is no overflow of electrolyte. In fact, our batteries are all enclosed in the battery case, with no exhaust for electrolyte. Primary battery design is of such a nature that extended time after activation up to 12 hours may be obtained before having to use them.

Correspondingly, we are not aware of the necessity to charge the silver-zinc secondary batteries as often as indicated. In one torpedo, we have a six-month charged stand in fleet use, after which the required performance is obtained. The *Bomarc* uses Yardney secondary batteries with a 60-day maintenance check. Practically all the torpedoes are set up on a 90-day charged stand basis and still give the required performance.

We feel that any adverse impression which may have been given on both primary and secondary silver-zinc batteries should be corrected and brought to the attention of your readers. A large number of them are quite familiar with the performance of the Yardney Silvercel described above which has made possible many of the recent advances in the missile and torpedo fields.

Paul L. Howard, Asst. Vice Pres.
Yardney Electric Corp.
New York City

Nowheresville

To the Editor:

I give up. Where is the 60th Air Force based? (M/R, April 25, p. 40).

K. T. Little
Manhattan Beach, Calif.

In a typographical error. The word "60th" should have been "both."—Ed.

reviews

ELECTRONIC COMPUTERS PRINCIPLES AND APPLICATIONS, T. E. Ivall. Philosophical Library, New York. 259 pp. $15.

This book is intended as a non-mathematical introduction to the principles and applications of electronic computers. It is aimed at the technician, engineer, and student with some background in electronics and is a rather general treatment of the broad background of computing.

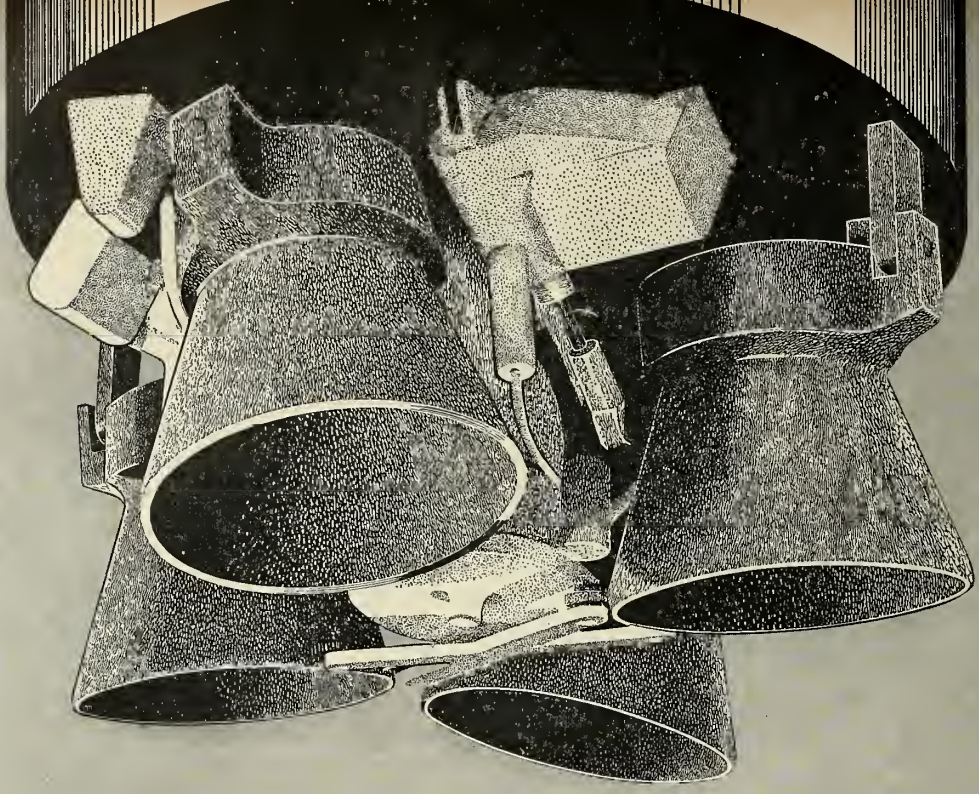
Except for "valves" and some other British terms and construction, the book is easily read and interesting. It will be especially useful to anyone requiring a general knowledge of computer operation without the mathematics and technicalities of design theory.

This is the second edition of a book first published in 1956 and reprinted a year later. It has been almost entirely rewritten, to bring the information up to date, and three new chapters have been added.

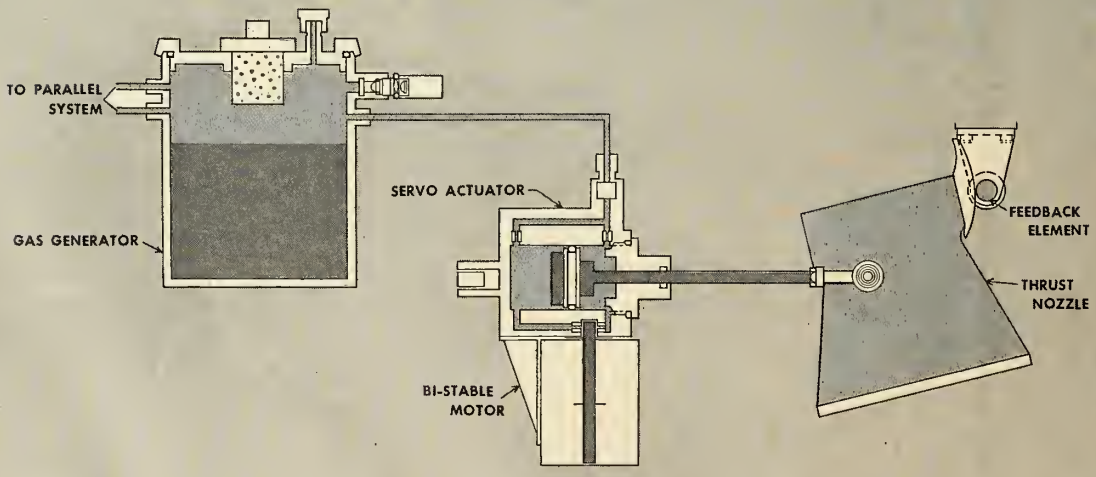
BASIC RESEARCH RESUMES—A SURVEY OF BASIC RESEARCH ACTIVITIES IN THE AIR RESEARCH AND DEVELOPMENT COMMAND. Herner and Co. for ARDC. Order PB 161291 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 342 pp., $5.

Most of the 1400 scientific research projects described in this index are being conducted at leading U.S. colleges and universities. Other projects are the work of industrial laboratories, government facilities, and private, non-profit research institutions. About 14% of the research is assigned to ARDC's own labs, while 20% is done outside the U.S.

All work is listed under 24 subject categories which cover six technical areas: propulsion, materials, electronics, geophysics, biosciences and areomechanics. There are two research sections and three indexes.



BI-STABLE SYSTEM HIGHLIGHTS CECO HOT GAS DEVELOPMENTS



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HOT GAS ACTUATION SYSTEM IN CECO'S BI-STABLE MODE IS

more accurate

insensitive to solid fuel contaminants

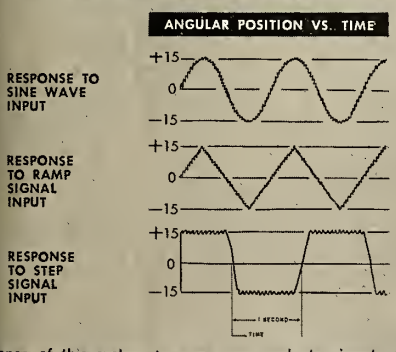
To position a mechanical load in response to an electrical command with minimum error, CECO has developed solid-fueled hot gas actuator systems operating in a bi-stable mode.

In a closed-loop arrangement, increasing the system gain to the point of *infinite* gain produces bi-stability, i.e., the servo valve can assume only two positions: fully closed in either direction. Maximum corrective torque is thereby applied to the load for all errors. With infinite gain, the system will sustain steady-state, limit-cycle oscillation, and the average steady-state error is zero. This is significant in systems with large stiction loads, since proportional controls of conventional philosophy permit larger errors before stiction torque is overcome.

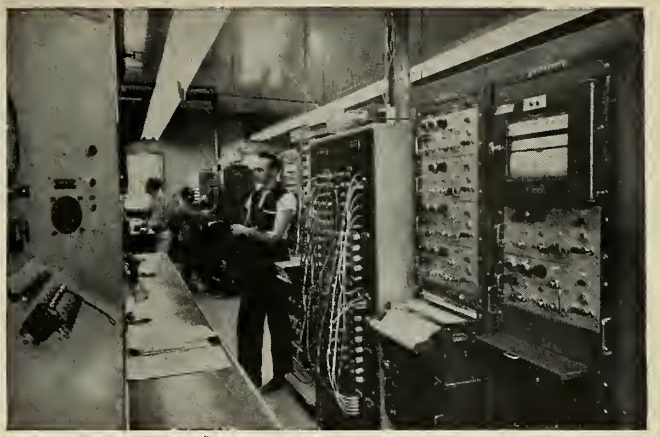
Among applications for CECO's limit-cycle, bi-stable philosophy is *thrust-vector* control. A representative portion of such a system is shown schematically at the left. This design utilizes push-pull actuators. The bi-stable motor, valving and actuators are an integral unit. One large servo-actuator positions the mechanically-linked pitch nozzles, while two smaller actuators position the remaining nozzles in response to yaw and roll commands.

CECO's experimental development program has demonstrated that because of its inherent accuracy and insensitivity to contaminants, the bi-stable control is more reliable than other proportional configurations for solid fuel applications.

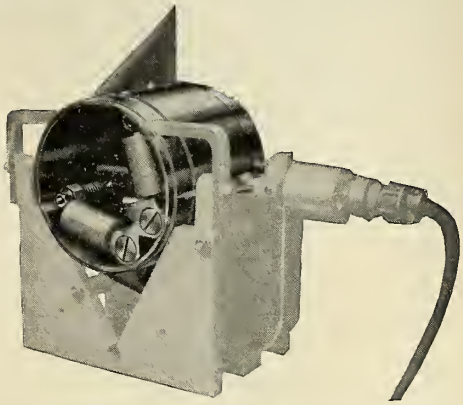
TYPICAL PERFORMANCE OF A BI-STABLE CONTROL



sponse of this system to sine, ramp and step inputs (while ing a conventional torquemotor) is illustrated. With new com nents being readied, limit-cycle amplitudes of one-tenth of one degree are expected.



Much of CECO's hot gas system and component development work is carried out in a special facility comprised of the above control room and its associated test cells.



Shown mounted in a test rig, this CECO hot gas system was designed for control-surface actuation.

Familiarity with systems engineering and with precision manufacturing for aircraft and missiles has served CECO well in its extensive work with hot gas servo control systems.

Both actuation and reaction systems have been designed, developed and produced for use with high-pressure hot gas generated from either solid or liquid propellants.

An up-to-the-minute, color-slide presentation containing technical data and a review of hot gas component and system hardware development activity at Chandler Evans is currently available. To arrange to have this presentation given before an engineering group in your company, call or write your nearest CECO Field Engineering Office.

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The Countdown

WASHINGTON

Second Thoughts on Mercury

Many leading U.S. scientists are growing convinced NASA, in Project *Mercury*, is taking the wrong approach to putting a man in space. Reason: The capsule's environment is too synthetic to obtain good data—even if the astronaut returns alive (which they doubt). They feel instruments will produce more deep space knowledge and that the Air Force *Dyna-Soar* actually is the best means of acquiring useful scientific and engineering data.

Minuteman to Get Tougher

Harder and harder underground *Minuteman* bases are being planned by the Air Force to increase the missiles' chances of survivability. Base specs will be raised soon from 100 psi to 200 psi.

Nuclear submersible hydrofoil?

Most advanced designs for missile-launching hydrofoil ships now being studied by the Navy are not only nuclear-powered, but also submersible. The submersible version would have the advantage of hiding under the ocean. It would pop to the surface to fire its missiles—either against shore installations, ships, subs or sub-launched missiles.

Titan Making Up Time

Big push is on by the Air Force to put the the Martin *Titan* ICBM back on schedule. If present test series continues to make up for time lost by earlier failures, the AF hopes to launch operational model *Titans* in October from Vandenberg AFB—one raised from a silo on an elevator, and a second directly from the silo. The shots would put the 98-ft. missile near operational readiness by the end of the year—the original timetable.

Dust Boating on the Moon?

Just in case the moon turns out to be covered with dust 200 ft. deep, someone has presented the Pentagon with a design for a "dust ship." The vessel is designed to "float" on the surface and is self-propelled.

INDUSTRY

Hot Bidding for Mobile Zeus

More than 80 companies are now in the competition for a $250,000-$450,000 feasibility study contract for a mobile *Nike-Zeus* launcher. Since the hardware potential is so huge, many industry giants have teamed up. One combination is said to be General Electric and Chrysler Missile Division. Bids are due July 5, with the contract award expected in September.

Competition on 1500-mile Polaris

The Navy's Allegany Ballistics Lab—operated by Hercules Powder Co.—and Aerojet-General are competing for the second-stage motor of a 1500-mile *Polaris*. Both have worked on the 1200-mile motors. Field is wide open, however, on the 2500-mile version—which won't come along until 1964-66 and depends upon advances in solid propellant technology being sought under ARPA's Project *Principia*.

Word from the Cape

Chrysler Corp., which lost the *Saturn* second-stage airframe contract to Douglas, has dropped an option on a large tract of land near the AF Missile Test Center at Canaveral . . . Maj. Gen. Leighton Davis is due to take over command of the Cape soon, succeeding Lt. Gen. Donald N. Yates, who has been put in charge of all ranges . . . and the AF is cramped for *Atlas* pads, with two of the four at the Cape now out of action by launching explosions.

Huntsville Watches Agena-B

Modification by Lockheed of the *Agena-B* satellite for NASA uses will be supervised by the Marshall Center at Huntsville.

Front Office Changes

Edward T. Clare has left Convair, where he was manager of support services for the *Atlas* program, to become marketing vice president of Cohu Electronics, San Diego . . . The Martin Co. has appointed Bastian Hello program manager for the rocket booster portion of the *Dyna-Soar* project.

INTERNATIONAL

More from the U-2

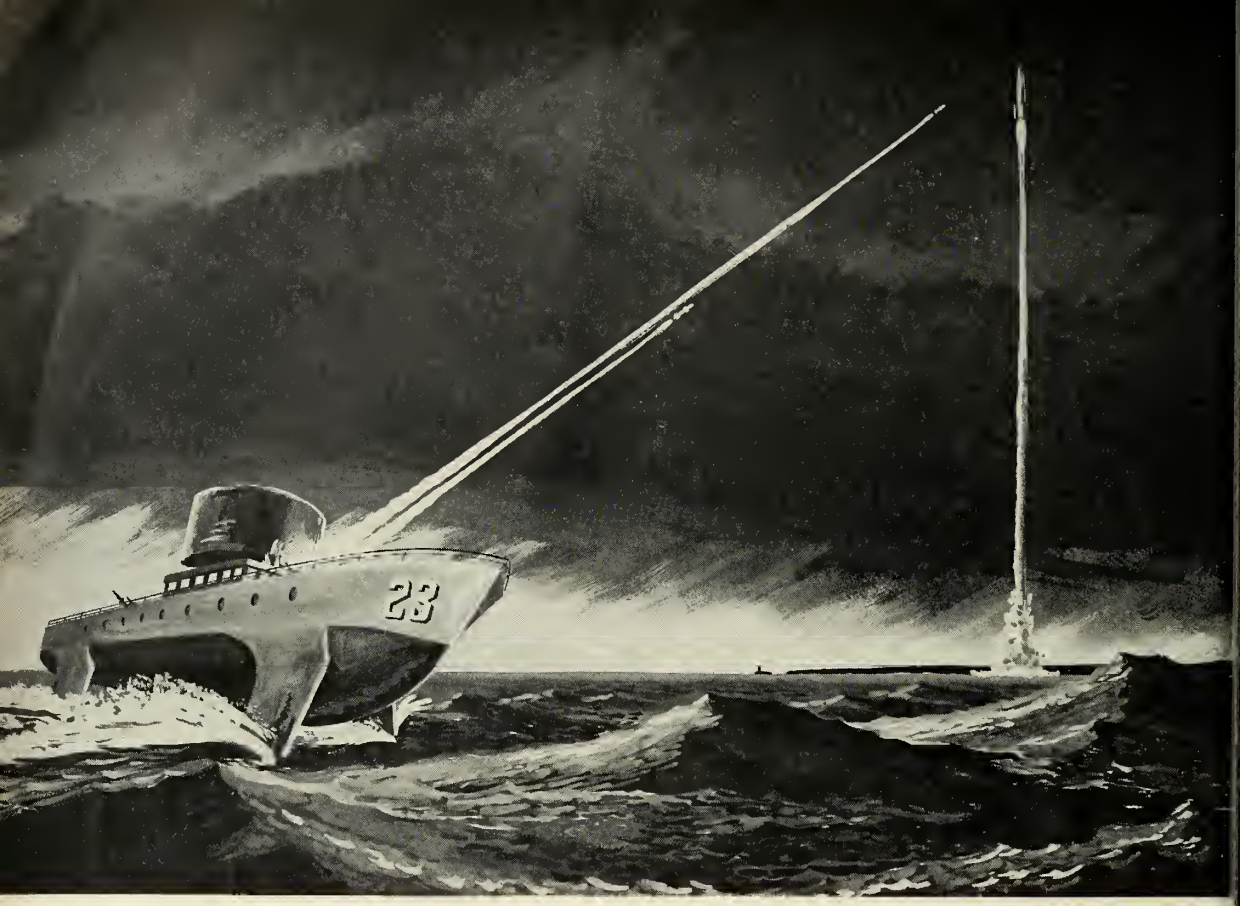
U.S. intelligence agents detected three Russian launch failures at their Aral Sea launch base prior to the successful firing of the 5-ton *Sputnik IV* on May 15. The type of vehicles which failed was not determined.

British Missile Makers Merge

Missile and aircraft interests of Vickers-Armstrongs, English Electric and Bristol Aircraft are in the process of being taken over by the new British Aircraft Corp. The new firm, to avoid large tax payments, is being organized as a Vickers subsidiary.

New Hawk Participant

West Germany's Bolkow-Entwicklungen K.G., maker of the *Cobra* antitank missile, is expressing interest in joining the NATO team producing the Raytheon *Hawk* antiaircraft missile under license. Prime for NATO on the *Hawk* is France's SETEL.



An M/R Artist Conception

Answer to missile subs? . . .

Navy Considers Hydrofoil Fleet

by James Baar

The Navy's answer to the Soviet missile-launching submarine may be an antimissile missile-packing hydrofoil destroyer.

The Navy is seriously considering the development of a hydrofoil destroyer as the first of a great fleet of possibly several hundred.

The Missile Age "greyhounds of the sea" would:

- Carry antimissile missiles that would knock down an enemy missile as it broke from the surface of the sea.
- Carry antisubmarine missiles that would strike at enemy submarines deployed off U.S. coasts.
- Displace between 300 and 500 tons and speed over the sea at between 60 and 100 knots—almost two to three times as fast as any surface warship in the Navy.

The hydrofoil destroyer, if approved by the Navy and Defense Department, would be the follow-on ship to the much smaller and slower hydrofoil subchaser on which the Navy has been taking contract bids. The hydrofoil subchaser—known as the PCH—will displace about 100 tons. Its maximum speed will be about 45 knots.

The fleet of several hundred hydrofoil destroyers could be deployed around the presently soft flanks of the continental United States. This force, in conjunction with other antisubmarine forces and detection systems, would be designed to keep track of enemy subs lurking on station and to cripple any attempt to launch an attack on the mainland.

The hydrofoil destroyer also would have offensive capabilities.

Such ships, all seaworthy and capable of travelling up to 5000 miles without refueling, could launch surface to surface missiles with ranges of several hundred miles. A new missile—possibly a greatly cut-down *Polaris*—would be needed for this mission.

On the other hand, the Navy already is developing the Westinghouse *Typhon* antimissile missile for shipboard use. The *Typhon*—an outgrowth of the Bendix *Talos*—could be adapted to a hydrofoil destroyer.

- **Small target**—Another possibility that has been suggested is the development of a seagoing version of the Convair *Mauler*—the Army's battlefield antimissile missile now under development. The entire *Mauler* system is reported to weigh less than 10 tons.

Besides speed, the hydrofoil destroyer has two other big advantages:

• It would be relatively cheap. The average cost for each of a fleet of 50 is estimated at about $7 million. The Navy's new guided missile destroyers cost about $34 million. Also, a crew of only about 25 officers and men would be needed for a hydrofoil, compared to the some 300 aboard a guided missile destroyer.

• It would present a difficult target. The only target a submarine would have to launch torpedoes at would be the thin foils—moving at better than 60 knots. The hydrofoil destroyer's speed and great maneuverability would make it an equally poor target for a surface- or air-launched missile.

A contract for the PCH prototype is scheduled to be let by July 1. The ship is expected to be completed in about two years. Under normal procedures, the next step would be the development of the first hydrofoil destroyer after test and evaluation of the PCH.

But many experts in the Navy and industry feel that the development cycle of the hydrofoil warship can be accelerated.

They contend hydrofoil technology is sufficiently advanced to move swiftly into the development of the hydrofoil destroyer.

• **500-tonner possible**—Grumman and its affiliate, Dynamic Developments, are already working under a Maritime Administration contract on an 80-ton R&D hydrofoil that would have a maximum speed of about 60 knots. Hydrofoil advocates contend that there is no reason to think that a ship displacing 300 to 500 tons can't be built.

They say the border of present hydrofoil technology is at about 65 knots. Beyond that speed, more development is needed—particularly in materials and the design of supercavitating foils.

Some research in this area is already underway. Several companies also have designs for a second generation hydrofoil destroyer that would operate on nuclear power.

The principal argument for proceeding as rapidly as possible with the development of a hydrofoil destroyer is the expected coming threat from Soviet nuclear-powered submarines. The Russians are expected to begin deploying missile-launching nuclear-powered subs off U.S. coasts by about 1965. Such subs can outrace any conventional warship now afloat.

Moreover, the Russians already have a number of much slower diesel-powered subs capable of launching missiles with ranges up to more than 300 miles.

The Navy sees this threat growing in seriousness in the late 1960's. Therefore, work on the first hydrofoil destroyer would have to be started within about a year in order to have a sizeable fleet of them available in time.

Some of the companies that have shown considerable interest in the Navy's hydrofoil programs:

Arma Division of American Bosch Arma Corp.
Boeing Airplane Co.
Bullard Co.
Convair Division of General Dynamics Corp.
General Electric Co.
Grumman Aircraft Engineering Corp.
Hughes Aircraft Co.
Librascope, Inc.
Lockheed Aircraft Corp.
Loral Electronics Corp.
North American Aviation, Inc.
Pratt & Whitney Aircraft Division of United Aircraft Corp.
Raytheon Co.
Westinghouse Electric Corp.

The hydrofoil, which many in industry predict will have a bright future both commercially and in the Navy, is nothing new. An Italian, Enrico Forlanini, is usually credited with operating the first hydrofoil craft in 1905. Alexander Graham Bell, inventor of the telephone, built a hydrofoil in 1911 after visiting Forlanini.

Large commercial hydrofoil ships have been in operation in Europe for years. Russia operates one of some size on the Volga River. However, these ships are not considered capable of operating in the open ocean.

• **Supercavitation**—However, two developments in recent years have opened the way toward large, ocean-going hydrofoils of great speed:

One is the development of the relatively light gas turbine jet engine which can be converted for powering a hydrofoil ship. A G.E. J-79 will be used on the Maritime Administration ship. Two or three engines of this size would be needed for a hydrofoil destroyer.

Needed for the development of a hydrofoil destroyer weapon system or later advanced systems:

• A seagoing 200-300-mile-range solid-propellant missile—possibly a modified Junior *Polaris*.

• A seagoing antimissile missile—possibly a modified *Typhon* or *Mauler*.

• New materials

• Advanced supercavitating foils

The other key development is the supercavitating foil—a hydrofoil designed so that a water vapor cavity that forms on the top of a foil at high speed does not collapse and create vibration. Without such a foil, speed is limited to not much more than 60 knots.

The supercavitating foil will not be used on the Maritime Administration ship but would presumably be used on a hydrofoil destroyer.

Despite Russian work in the field of hydrofoil, Navy planners generally do not believe the hydrofoil has nearly as much promise as an antisubmarine weapon for the Russians as for the United States. The reason is geography.

The long open coasts of the North American continent could be protected by squadrons of hydrofoil destroyers operating out of home ports or friendly bases in Europe and the Caribbean. Moreover, they would be backed by shore-based and other ASW detection systems. All of these ocean areas are controlled by the United States or friendly powers.

On the other hand, the *Polaris* submarine threat to the Soviet Union is based in the waters surrounding the Eurasian land mass. These waters, except for those off northern Siberia and the Siberian Pacific Coast, are not controlled by Russia. Therefore, ASW surface operations in these uncontrolled areas would be extremely difficult at best.

It is doubtful that the hydrofoil destroyer will be Russia's defense against the missile-launching submarine. But it may very well be America's.

—news briefs—

Second Saturn Static Test Succeeds—The huge *Saturn* booster was ignited for the second full static test of its clustered eight engines May 17 at NASA's Marshall Flight Center. The booster developed more than 1.3 million pounds of thrust for nearly 30 seconds.

Polaris Second Stage "Fix" Works—An all-but operational *Polaris* roared about 1000 nautical miles down the Atlantic Missile Range May 18, proving that a malfunction that had been causing *Polaris* second stages to fall short has been corrected.

Missile Construction Bills Vary—The House Appropriations Committee approved a slashed military construction money bill with $300 million for the Air Force ballistic missile program. The Senate Armed Services Committee authorized $408 million.

Year Was Lost in Dyna-Soar Program

by William J. Coughlin

SEATTLE—Extensive technical re-evaluation now shows clearly the United States has wasted a year in going ahead with the *Dyna-Soar* program.

This conclusion is generally drawn from the final study that preceded the release of funds April 27 to begin the first phase (Phase Alpha) of the huge project. On that date, the Air Force made available $29.7 million for design and ground testing facilities needed to build a boost-glide "aerospace test vehicle."

The program has been delayed by years of haggling over the best approach in vehicle design and a great deal of skepticism in the Eisenhower Administration and the Defense Department.

However, experts connected with the program say today that the United States has possessed the technology to build the *Dyna-Soar* for a full year. The major difficulty, apparently, has been in convincing scientists and officials in Washington to this fact.

• **'Unlimited possibilities'**—Now that it has succeeded in getting the program underway, the Air Force has made it clear to Boeing Airplane Co., which is building the glider vehicle, that *Dyna-Soar* will be a strategic weapon system not only for manned reconnaissance, but for orbital bombing as well. Gen. Thomas S. Power, commander of the Strategic Air Command, emphasized this role for *Dyna-Soar* on a recent visit here, adding that as a weapon it had "unlimited possibilities." His remarks contrasted sharply with the purely scientific emphasis that NASA has placed on *Dyna-Soar* and also underlined the Air Force's determination to utilize it in establishing a strategic mission in space.

George H. Stoner, *Dyna-Soar* program manager, told M/R in an interview last week that there are no major problem areas to be solved in pushing ahead with the *Dyna-Soar* program. Everything which must be accomplished, he said, is within the present state of the art.

• **No changes needed**—Stoner said no major changes had been made in the *Dyna-Soar* configuration or program as a result of the Phase Alpha re-evaluation. Configuration of the *Dyna-Soar* space-glider is that of a modified Delta with a platform which juts out more abruptly toward the wingtips.

Stoner said that the re-evaluation of the program did not change in any way the conclusions that the Air Force, Boeing and The Martin Co., which is modifying the *Titan* ICBM as the booster, came to a year ago.

He made it clear that he felt the program could have been pushed ahead at a faster pace but acknowledged that Phase Alpha had succeeded in transmitting to the scientific community the conclusions reached in secrecy in the competitive stages. These conclusions, he said, now have been accepted.

Detailed specifications for the *Dyna-Soar* vehicle and booster are being drawn up—specifications for the major subsystems also are being defined and contracts will be let in competitions later this year.

A definitive mockup is already in existence here at the Boeing plant.

• **Modifying**—A number of changes are required in the *Titan* missile which will boost the *Dyna-Soar* vehicle. These are intended to handle the structural and stability problems which will result from mounting the aerodynamic shape on the front of the missile.

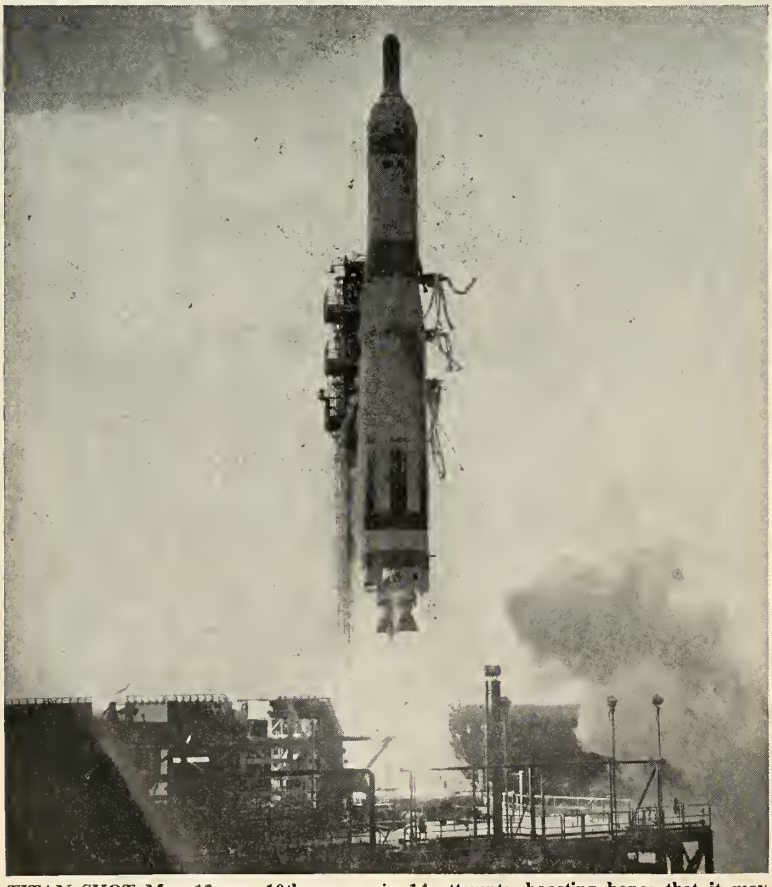
Major change will be the addition of fins in the control system or possible control deflection within the engine arrangement. Final decision on this still is to be made.

Structural requirements in beefing up the *Titan* for its *Dyna-Soar* booster task are relatively modest. Separation techniques will not be unlike those used in present multi-stage ballistic missile configuration.

• **Saturn by '65**—*Dyna-Soar* development program calls first for air-drops of the space-glider from a B-52 at Edwards AFB, Calif., sometime in 1963.

These will be followed by ground-launching of the unmanned glider atop the *Titan* at Cape Canaveral, Fla., and then down-range launching of the manned glider. Next step will be launching of a manned glider from Cape Canaveral around to Edwards AFB, Calif.

By that time—1965—A *Saturn* booster is expected to be available to put the *Dyna-Soar* into orbit.



TITAN SHOT May 13 was 10th success in 14 attempts, boosting hopes that it may be operational this year. Martin is modifying *Titan* as *Dyna-Soar* booster.

Firing of Kiwi A Prime Reactor Nears

AEC now expects to carry out first test firing in July; nuclear ramjet static test may come before November

by Frank G. McGuire

JACKASS FLATS, NEV.—The Atomic Energy Commission expects to test-fire the first *Kiwi A* prime reactor in the *Rover* program by mid-July, using a "real step forward" in nuclear fuel element design.

Following tests of the *Kiwi A* prime, Los Alamos Scientific Laboratory, which has design, development and test responsibility for the *Rover,* will begin tests on *Kiwi A3.*

The two reactors, similar in outward appearance to each other and the original *Kiwi A* series, will be disassembled and examined after their initial runs are completed. AEC has expressed complete satisfaction with the first test of *Kiwi A,* which was operated at full power on July 1, 1959, for "less than ten but more than three minutes." There was reference to an unexplained "fortuitous incident" during the run, which is believed to have contributed to its success.

• **Sacrificial**—In the upcoming tests here, AEC will run *Kiwi A3* to death deliberately, to provide experimental information on the behavior and limitations of materials used. Materials constitute one of the major operating problems presently, and intensive research is being carried out to improve the temperature limitations of the reactor series.

Cold flow experiments are now being conducted on the mockup of *Kiwi A* prime here, in order to check out turbo-machinery and other subsystems, rather than have a minor component cause trouble during hot runs. In these tests, gaseous hydrogen is run through the mockup system to test control instruments, diagnostic sensors and the propellant system. The mockup is identical to the hotreactor with the exception of nuclear fuels, which are absent. Cold flow tests are being conducted at Test Cell A, rather than Cell C, which will utilize liquid hydrogen.

• **Tory tests coming?**—AEC officials also indicated strong possibilities that the nuclear ramjet program, *Pluto,* will be static-tested here by November and possibly sooner. The Tory I reactor is about the size of the *Kiwi* series reactors, but no information is available regarding performance figures. A longer test period is expected for the Tory I than that held for *Kiwi A,* but again, no details were given. The Tory I will be tested in much the same way as the *Kiwi* series, with the exception of horizontal, rather than vertical, mounting on the test bed.

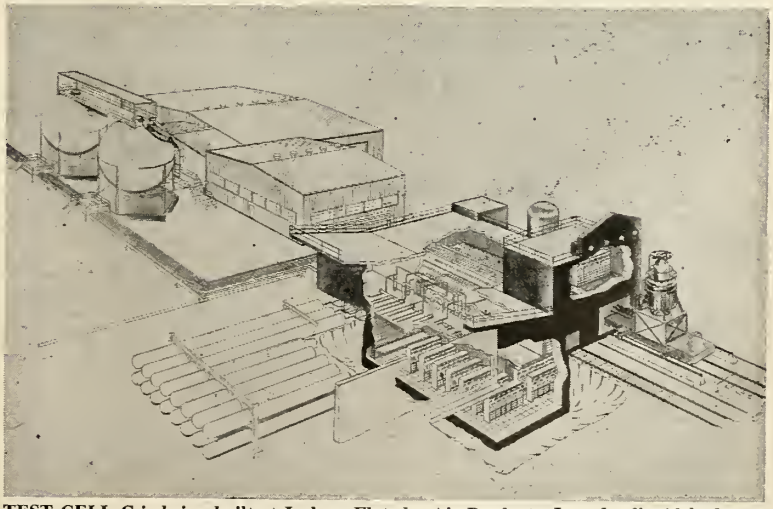
Like the *Kiwi* series, the Tory I Reactor will be completely disassembled and inspected after its firing is complete. LASL scientists here admit a general lack of knowledge about specific effects on a reactor from firing with hydrogen, especially in its liquid form. The "real step forward" cited in fuel element design may have been aimed at learning more in this area. Tests thus far have been with gaseous hydrogen. The disassembly building for Tory I is partially completed. AEC and LASL officials expressed doubt that a *Pluto*-propelled vehicle would cause greater contamination than *Rover.*

Thrust levels for all the nuclear propulsion devices were not revealed and Dr. Keith Boyer, test director for the *Rover* program, emphasized that thrust levels are not the prime objective of any of the *Kiwi* reactors. He indicated that these levels would be the objective of much later tests, and cited the most pressing present problems as: the need for fuel element and materials technology advances; the study of hydrogen on the reactor and associated systems; and engine system problems, such as operation of machinery in a radiation environment.

• **Burden of Ignorance**—Estimating a general timetable for *Rover* flight tests, Dr. Boyer was reluctant to predict any such schedule, but said his group would need "a lot of luck and some stretching of our technical capabilities as a nation to fly one before 1965. The biggest problem we face," he added, "is our own state of ignorance about what the real problems are." He indicated that money alone would not solve all the problems facing *Rover,* and even a crash program would be extremely fortunate to improve much on the 1965 minimum flight test estimate.

To date, there has been only one full-power run of the *Kiwi A* reactor, and it was stressed that nuclear reactors for propulsion do not require the frequent testing needed by chemical rocket engines. During the power run last July 1, the *Kiwi A* was operated at varying power levels for several minutes. Thrust was not measured, and temperatures reached are classified. Future tests may determine the minimum time required for attainment of full power from zero, and also the feasibility of start/stop capability of such propulsion systems.

The control rod assembly and other similar instrumentation was assembled with the *Kiwi A* prime hot reactor on May 17 here, constituting a major step in completion of the device. The control rods in this model are immersed in heavy water as an added protection. The reactor assembly is approximately 12 ft. high and 6 ft. in diameter, exclusive of control devices.



TEST CELL C is being built at Jackass Flats by Air Products, Inc., for liquid hydrogen flow tests next year. Gas will be stored in large tubes at left.

Congress Rejoins Debate Over Gap

The great Missile Gap debate revived this last week over an Administration plea in the teeth of the Summit Conference collapse that Congress cut the House-passed Defense Appropriations Bill.

Deputy Defense Secretary James Douglas asked the Senate Defense Appropriations Subcommittee to slash $1.3 billion House additions to the bill and restore $987 million of House cuts.

Douglas request included:

- Cuts of $241 million for *Polaris;* $54 million for the *Samos, Midas* and *Discoverer* satellite programs; $20.7 million for *Minuteman;* $221 million for ASW subs and surface ships: $115 million for an airborne alert; $100 million for air transports; $215 million for 50 missile-packing F-106 jet interceptors.
- Restoration of $294 million to complete 10 squadrons of *Bomarc B;* $400 million for procurement across the board; $293 million for a diesel-powered aircraft carrier.
- Acceptance of $695 million added by the House including $207 million for Army missiles and other new equipment and $100 million for ASW R&D.

The reception by Senate Leaders was icy. Chairman Richard Russell (D-Ga.) of the Armed Services Committee told Douglas U.S. strength apparently wasn't even sufficient to persuade Soviet Premier Khrushchev to "use the ordinary means of diplomacy." Stressing the need for U.S. strength, Russell said: "I'm afraid that we didn't have it in Paris."

Senate Democratic Leader Lyndon Johnson (D-Tex.) noted caustically on the Senate floor that defense budget outlined by Douglas is just "$500,000 or one thousandth of one per cent below the original budget request."

"The inference is clear," he said. "Once a budget amount is set no one in the Executive Branch is permitted to present military needs that may call for budget increases. The whole world situation may be changed by the Summit Conference and the events of the next few weeks, but the preparedness program must be held to a magic ceiling established by the budget director."

- **Raised eyebrows**—Besides Douglas' call for cuts, the item in his request that raised most congressional eyebrows was the Boeing *Bomarc B.*

The House Appropriations Committee had had little good to say for the missile and had eliminated all funds for it not already firmly committed. It chose to buy more jet interceptors, instead.

Douglas warned that the elimination of *Bomarc B* funding will leave a serious gap in U.S. air defenses. He said the new jet interceptors could not be deployed until a year after the date scheduled for deployment of *Bomarc B.*

His testimony was backed by recent successes in *Bomarc B* tests. A *Bomarc B* soared 270 miles over the Gulf of Mexico 24 hours before Douglas testified. Another of the 400-mile-range missiles was successfully launched last month.

The launchings brought the revised Air Force test score for *Bomarc B* to seven partial successes, two successes and one failure. Five of six *Bomarc A's* fired this month in training exercises scored hits on drones over the Gulf.

AF Cutting Basic Research

Unless there is a quick reversal in policy, the Air Force will begin de-emphasizing its contractual basic research programs early this summer. Personnel and money will be shifted into directed research.

Word of the forthcoming move already has touched off a rumble of discontent among highly-placed civil service scientists. Universities and companies involved in basic research can expect a crimp in funding if the change goes into effect.

Red Astronaut Launch Hinted

Four days after Russia launched a 9988-lb. "space ship" into a nominal 200-mile orbit last week, a top U.S. space scientist conceded the Soviets were "ready for a manned shot."

There was speculation that the new *Sputnik IV* launched May 15 actually held one or more live astronauts rather than a "dummy spaceman" as claimed by the Russians.

Rather than minimizing the latest Soviet shot, as some scientists did immediately after it was launched, ARDC's Brig. Gen. Don Fleckinger said the large space vehicle actually was engineered to solve many re-entry problems.

Fleckinger, who is assistant for bio-astrophysics at ARDC headquarters, said the Russians have the capability to put more than one astronaut aloft. The Russians said the "space ship" included a 5510-lb. pressurized cabin containing a dummy spaceman, instrumentation weighing 3249 lbs. and power supply sources.

Fleckinger said the pressurized cabin inside an outer shell afforded these advantages:

- The cabin with its great amount of instrumentation gives greater reliability in case of deviation from the scheduled flight path.
- During re-entry the heat is contained in the outer shell and when the cabin is ejected it relieves itself of the heat stored in the outer shell. This improves chances of survival.
- There is protection against misalignment of thrust and stabilization which might push the space ship into an eccentric orbit into the Van Allen belts, since the outer shell would receive the radiation exposure. The inner cabin could be ejected from a safer altitude.

Purpose of the launch, according to the Soviet statement, was to "perfect and check the satellite ship's system, insuring its safe flight and controls, its return to the earth and the necessary conditions for the space crew."

"In this case," the Soviet statement said, "it is not planned to retrieve the pressurized cabin, which after due checking of its reliability in operation and separation from the space ship, will as the space ship itself, begin descending on command from the earth, and burn up in the denser layers of the atmosphere."

The launching of *Sputnik IV* also coincided with the beginning of the ill-fated Summit Conference in Paris, and with the second anniversary of the launching of *Sputnik III,* which disintegrated in the atmosphere April 4. *Sputnik III* had held the weight record for an earth satellite, 2925 lbs.

Many leading U.S. scientists were wary of the Soviet announcement that the space vehicle's cargo was a "dummy." Pointing out that it would be illogical to command a vehicle by retro-rockets to burn up in the atmosphere, these scientists theorized that the Soviets may have actually put a man in space but did not intend to announce this fact unless they brought him back alive.

Expansion at Radiation

RADIATION, INC. recently dedicated a $1,450,000 electronics facility at Melbourne, Fla., including this administration building and national headquarters. The headquarters contains 42,900 square feet of floor space. Three "engineering modules," each containing 22,000 square feet of work space, are located adjacent to the headquarters. Construction is first phase of a multimillion-dollar building program to meet expanding needs of the rapidly growing firm.

Missiles Now Develop Faster Than Aircraft

Development time for missile systems has turned out to be less than for aircraft, William B. Bergen, Martin Co. president, declared last week.

Bergen and three other top industry leaders spoke at a luncheon meeting of the Aviation/Space Writers Association in Washington. In other talks:

• Dan Kimball, Aerojet-General president, reported that missile propulsion systems are steadily becoming more reliable. As an example, he cited a recent test of a *Titan* first stage powerplant at Aerojet's Sacramento plant, in which it ran for 27 times the regular burning time without failure. That would be about 54 minutes.

• Buford M. Brown, Westinghouse vice president, predicted that the military electronics market—now $4.7 billion a year—will double in the next decade.

Brown urged missile electronics contractors to hire more mechanical engineers. He said more trouble in electronic systems has come from simple mechanical problems such as vibration and mounting than from the electronic equipment itself.

• Thomas V. Jones, Northrop president, declared that the news of the last two weeks has demonstrated that airframe manufacturing is not dead. However, Jones said the airframe industry must regard itself as an advanced technology industry. In World War II, he said, the airplane represented the most advanced form of technology. Today, there are many other examples.

Bergen reported that the shift from aircraft to missile manufacturing entails more changes in business methods than is generally believed. He gave these examples of differences between the two industries:

For physical facilities, the chief asset of an aircraft company is a plant with a high bay area. In the missile business, an important asset is an area of many square miles of barren desert.

"There were relatively a few companies in the aircraft business," Bergen said, "and we knew everyone in it. But it seems that everyone in the United States is in the missile business to one degree or another."

The missile business, he continued, has a heavier emphasis on science and engineering and less on production. Numbers are no longer as important as quality.

Bergen said he could not see why anyone should be excited about the flying of a reconnaissance airplane over Russia when, either now or very soon, the Russians will be able to obtain equally good photographs from the very large satellites they are able to launch.

financial news

Borg-Warner—Sales totaled $162 million, up 8% from 1959. Profits rose to $8.3 million, up from $7.8 million in the first quarter last year.

Thompson Ramo-Wooldridge—First quarter sales rose to $111.6 million from $92.2 million in the first quarter last year. Sales in electronics, missile and space fields rose about 50% from a year ago.

mergers & expansions

LING-TEMCO ELECTRONICS INC.'s president will be James J. Ling chairman and chief executive officer of Ling-Altec Electronics Inc., instead of Clyde Skeen (M/R, May 2, pg. 18). The switch in leadership of the proposed new company is said to stem from unrest among Ling-Altec stockholders over the earlier arrangement. Ling-Temco will be formed by a merger between Ling-Altec and Temco Aircraft Corp. Skeen, executive vice president of Temco, had originally been picked as head of the new company. Under new arrangements, he will become executive vice president.

AVIEN, INC., Woodside, N.Y. has purchased Colvin Laboratories, Inc. and Pressure Elements, Inc., both located in East Orange, New Jersey. Colvin manufactures electro mechanical instrumentation with applications to missiles and undersea devices. Pressure Elements produces pressure capsules for transducers.

LOCKHEED ELECTRONICS has bought Waldale Research Co., Inc., Pasadena. Waldale is a developer and manufacturer of load cells, strain gauges, position transducers and force gauges primarily for aircraft and missile applications.

UNITED TESTING LABORATORIES is expanding its testing facilities by 7000 sq. ft. The new section will contain specialized temperature controlled areas and will be largely devoted to proving out electronic components for *Polaris, Titan* and *Atlas* programs.

INTERNATIONAL ELECTRONIC RESEARCH CORPORATION has opened a new 30,000 sq. ft. facility in Burbank, Calif. The company manufactures dissipating shields for electron tubes, electronic instrumentation and does precision machine work for the missile industry

LEACH CORPORATION has created an international subsidiary, Leach International, S.A., keyed to expanding European and world markets. The new subsidiary will start immediately to market company products in the European common market. It also plans to manufacture abroad.

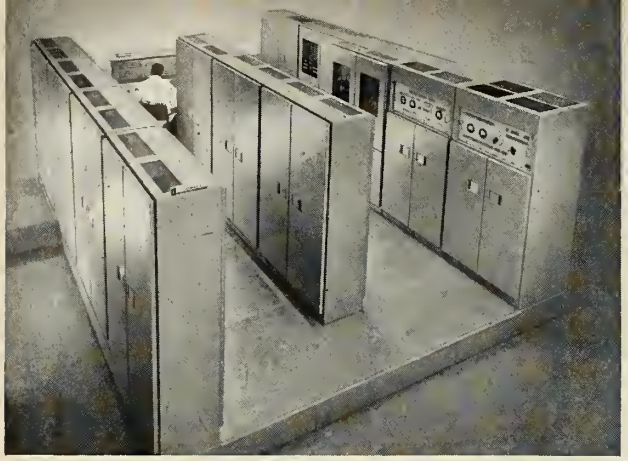
AMERICAN BOSCH ARMA has reorganized its commercial and military sales into two separate activities.

JAEGER-CORDRAY INC. manufacturers' representatives in Orlando, Fla. is now representing such companies as General Bronze and Stromberg-Carlson, San Diego. President of the new company is Jack M. Cordray, formerly with Martin-Baltimore and Martin-Orlando.

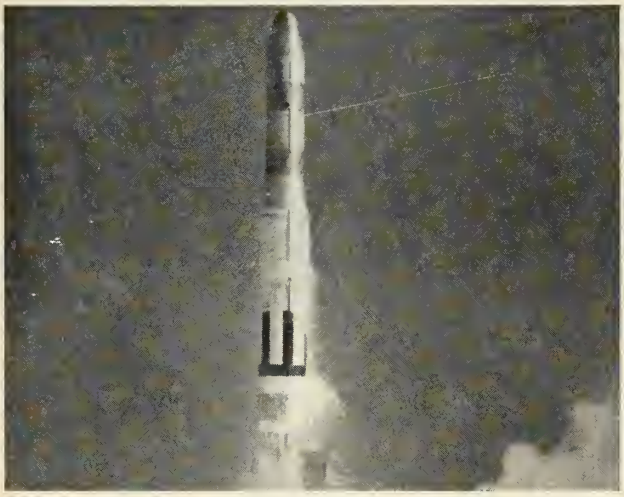
From the **REMINGTON RAND UNIVAC**

Military Division

Ultra-Reliable Athena Computer Guides ICBM Titan to Target 5,000 Miles Away



Building the Athena called for the development of new and rigorous quality control techniques to insure the reliability of its more than 100,000 components and 120,000 selectively soldered joints. All components were classified by Univac data processing equipment, which also kept permanent records of their performance.



Athena is the ground based guidance computer for the USAF Titan ICBM. The Athena continually computes the speed, elevation, direction, azimuth, and position of the Titan and compares this information with data stored in its magnetic memory. Responding to commands issued by the computer, the missile maintains a course which will put it on target.

Recently an ICBM Titan missile was fired from Cape Canaveral by the USAF Ballistic Missile Division. The accuracy of the ground-based guidance system was such that technicians were able to quickly recover a data capsule within a target area 5,000 miles away.

This same system made possible the highly successful launching of TIROS I, America's television-equipped weather-eye satellite. The Athena computer, guiding a three-stage Thor-Able type missile, put TIROS I into the most nearly perfect circular orbit of any satellite, Russian or American, yet launched.

The Athena Digital Guidance computer was designed and produced by Remington Rand Univac to meet unprecedented reliability requirements. Several Athena computers have since been delivered and have logged thousands of operating hours. All have exceeded a reliability rating of 99.992 per cent, a record considered as a major breakthrough in the computer art.

The Athena is now a proud addition to the distinguished series of defense systems developed by the Military Division. In exceeding the contract specifications for reliability and delivering the computer ahead of schedule, the Athena program once more demonstrated the outstanding military capabilities of Remington Rand Univac.

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BOMARC Computer for the U. S. Air Force Target Intercept Program

SEA SURVEILLANCE SYSTEM FOR THE U. S. NAVY

AN/USQ-20 (Advanced Computer for the U. S. Navy)

Additional information describing capabilities and experience or career opportunities may be obtained by writing to Remington Rand Univac at the above address.

Technical Countdown

ADVANCED MATERIALS

Strength at Hi-Temp Claimed

Unbelievable strength at temperatures close to the melting point may result from reinforcing metal matrices with ceramic fiber. Horizons Inc. is experimenting with the technique with an eye toward possible nozzle and nose cone applications. Early work was done with 80Ni-20Cr alloy reinforced with Al_2O_3 in sapphire or corundum single crystal form. Technique will be tried with other combinations.

Explosive Forming Studied

Under a contract with the Army's Watertown Arsenal, Ryan Aeronautical will test its explosive forming technique on aluminum, titanium and steel alloys in complex shapes applicable to missile use. Ryan will sink three new explosive forming pits in an uninhabited San Diego canyon area.

Steel Prices Cut

A new round of price cuts has pared an average of 13% from the cost of the specialty steels most widely used in missiles. Ladish D6 went from 85¢ to 74¢/lb. Crucible Steel, the producer, said it was the fourth cut for the one-time die steel, since it was introduced eight months ago at $1.13/lb. Universal-Cyclops cut about 13% from its high-strength low-alloy steels. Allegheny-Ludlum started the round of reductions with a new price list May 2; others followed last week. The cuts may pare as much as $200 from the raw material cost of each *Minuteman*.

NASA Buys Electron Furnace

NASA has bought an electron beam melting furnace for research in Tungsten at its Lewis Research Center in Cleveland. Stauffer Temescal will install the furnace, which will cast ingots 30 in. long and up to 6 in. in diameter.

GROUND SUPPORT EQUIPMENT

Umbilical Cords Protected

An Air Force captain was awarded $40 for a suggestion that missile umbilical cords be covered with flame-resistant materials to protect them from the heat of blastoff. Savings: $200,000.

Oil Rigs Serve as Gantries

The Army is using modified oil-drilling rigs for *Jupiter* launch equipment—with savings claimed in the millions. The gantries were originally modified for use with *Atlas* but were found unsuitable. They have also been used for servicing *Redstone, Jupiter-C* and *Juno II*.

Minuteman Blockhouse Designed

Lockheed Electronics Co. has designed the instrumentation for the *Minuteman* blockhouse and silo under a contract with AFBMD and the Flight Test Center at Edwards AFB. First phase of the program was completed in less than three months.

Rapid Data System Developed

Laboratory for Electronics has developed a high-speed data storage and display system that gives fractional-second access to a capacity of some 55 million alphanumeric characters stored on high-density magnetic file drums. The RASTAD system, which has a read/write bit rate varying from 90 to 400 kc, is for an undisclosed military application.

PROPULSION

AP Plant to Get Surplus Tag

The Navy wants to declare as surplus its ammonium perchlorate plant in Henderson, Nev., now operated by American Potash. Now that several producers are in the field, the Navy feels the industry no longer needs government help. The 18,000-ton-per-year plant would be sold to American Potash. Other AP producers—HEF (owned jointly by Hooker and Foote Mineral), Pennsalt and Pacific Engineering—are watching nervously.

H-E Solid Research Continues

Minnesota Mining & Manufacturing will continue its research into high-energy solid propellants through the end of 1960 at least. Bureau of Naval Weapons administers the contract, one of the first four granted under ARPA's Project *Principia* in 1958. The renewal totals more than $1.5 million.

Minuteman Production Plans Jell

Minuteman first stage will go into production in the summer of 1961. Bulldozers began clearing land earlier this month for the Thiokol production plant at Ogden, Utah.

ELECTRONICS

Solid Circuitry Lag Seen

Despite the ballyhoo about solid circuitry, there is a lead time of at least five years between present laboratory subsystems and large-scale use in complete circuitry, says Dr. Harper Q. North, Pacific Semiconductors' president. Today's proven microminiature semiconductor devices—such as PSI's Micro-Diodes—will fill the gap for some time to come, he told M/R. By 1961, he said, Micro-Diodes will compete in price with standard diodes.

Radar Overload Seen

Flyingdale site for BMEWS will be the most overworked in system. Radars will have to perform for two masters, detection and tracking. Many feel it won't be able to do both well.

ASW ENGINEERING

Mock Naval War Center Planned

Minneapolis-Honeywell's Ordnance Division will develop a $3.6-million nuclear submarine training center that will electronically simulate full-scale undersea battles. The trainer will occupy an entire wing of a three-story building at the Navy's New London, Conn., Submarine School. The heart of the center will be a Honeywell 800 digital data processing system.

ANNOUNCING A NEW CORPORATE NAME

for The Garlock Packing Company

Garlock Inc. becomes the new nome for The Garlock Packing Company, Palmyro, N. Y., to reflect more occurotely its broad diversificotion of products ond morkets.

Originally established to manufacture mechanical packings, Garlock now produces over 2,000 different styles of packings, gaskets, seals, molded and extruded rubber and plastic products for every major industry.

The new corporote name, Gorlock Inc., more closely identifies this 73-year-old company with the growth and development of its product lines. *Today, industry goes to Garlock for such widely diversified products as:*

- Hydraulic-Pneumatic Packings
- Oil and Grease Seals
- Gasketing and Expansion Joints
- Braided Packings
- Molded and Extruded Rubber Parts
- Plastic Stock Shapes and Fabricated Parts
- Mechanical Seals for Rotating Shafts
- Metal Packings
- Leather Packings
- Electronic Components
- Dry Bearing Materials
- Fluorocarbon Tank Linings
- Missile and Rocket Components

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At Gorlock Inc., design ond development of new or improved products and materials is an ever-present objective. To this end Garlock maintains extensive research and laboratory-test facilities. In addition, Garlock engineers and chemists are always ready to work with you in seeking solutions to tough application problems.

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To find out more about "the new Garlock," call the nearest of our 26 sales offices, or write to Garlock Inc., Palmyra, N. Y. *To assure prompt attention,* please refer to *Garlock Inc.* on all future correspondence and orders.

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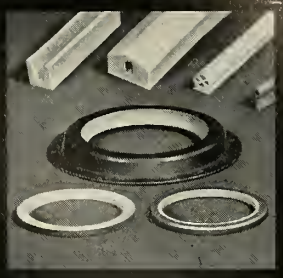
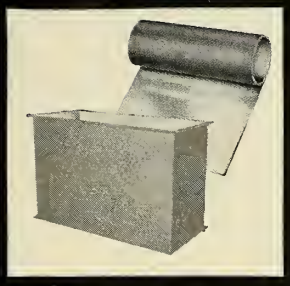


Molded and Extruded Rubber Parts

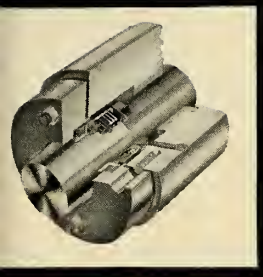
Plastic Stock Shapes
and Fabricoted Ports

Braided Packings



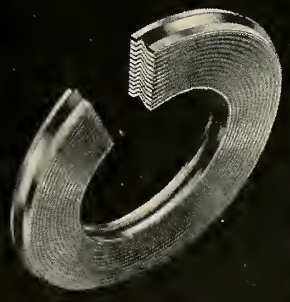
Fluaracarbon Tank Linings

Oil and Grease Seals

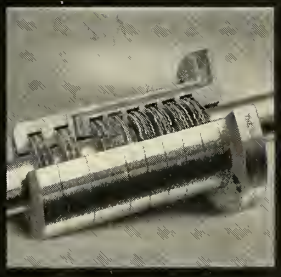


Mechonical Shaft Seals

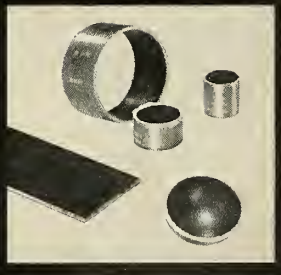
Gasketing



Spiral Wound Gaskets



Metol Packings



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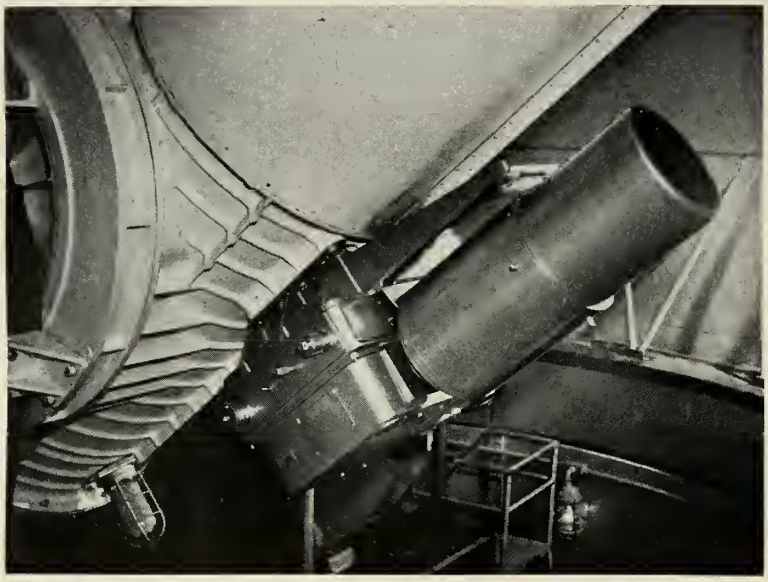
Missile and Racket Camponents

Leather Packings

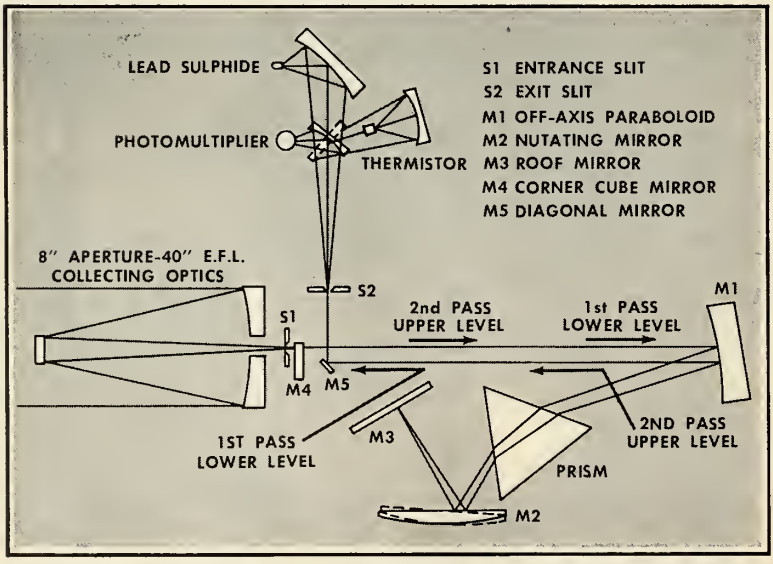
Electronic Camponents

IR Identifies Missiles by Plumes

Perkin-Elmer work south of Cape, highly classified previously, may lead to a major stride in detection-identification



COLLECTING OPTICS for the rapid-scan unit are contained in this 3-ft. tube mounted under the ROTI missile tracker. An 8-in. aperture and 40-in. effective focal length are employed. IR measurements are correlated with the ROTI photographic record.



FUNCTIONAL DIAGRAM of the collecting optics and monochromatic scanning system used in the IR rapid scan instrument.

by Charles D. LaFond

A major advance in missile detection and identification may be just over the horizon. It is now confirmed (see M/R, May 2, p. 21) that Perkin-Elmer Corp., Norwalk, Conn., is making infrared studies of missile-exhaust plume characteristics at the Air Force Missile Test Center, Cape Canaveral.

Through these spectrometric measurements during powered flight, missile performance data is being accumulated for use in identifying each bird by its exhaust-plume "signature."

IR measurement techniques for missile plumes, midcourse projectiles, and re-entry vehicles are still in their infancy. Nevertheless, results already indicate data will be very useful for missile detection, advanced IR homing systems for *Zeus*-type anti-missile missiles, development of decoy tactics, satellite tracking and detection and even nose cone improvements.

Technical details of the project have been highly classified until now, but Perkin-Elmer has just been able to release some of them.

The company is using its 8-in. "Rapid Scan"" IR system in conjunction with AFMTC's recording optical tracking instrument, ROTI Mark II. The tracking installation is at Melbourne Beach, about 30 miles south of the launching area at Cape Canaveral.

ROTI photographically records missile flights at great distances, and the data are used for correlation with the infrared measurements.

The study, being performed under an AF Cambridge Research Center contract, is another phase of the Interservice Radiation Measurement Program (IRMP 59/60), sponsored by the Advanced Research Projects Agency.

The Perkin-Elmer rapid scan equipment is used during all IRMP measurement periods. IRMP data for this and other ground and airbrone sources and channelled to the University of Michigan for classification and central filing.

• **Infrared recording**—Heart of P-E's IR system is the device called a rapid-scan monochromator. This unit records IR radiation intensity over a

particular waveband. Recording is continuous.

Wavelength range of the monochromator is from 0.3 to 3.6 microns; scanning frequencies are between 2.5 and 180 cps.

Collection optics in the modified ROTI Mark II system include a 40-in. effective focal length Cassegrainian telescope with an 8-in. clear aperture.

• **Scanning system**—The monochromator scanning system is composed basically of a plane mirror spinning about an axial shaft. Because the mirror surface is not perpendicular to the shaft, a scanning motion is achieved. Incident light is reflected from the mirror in a conical pattern.

The nutating mirror system thus functions as a Lithow mirror, except that reflected light components move in two directions—parallel and perpendicular to the dispersion plane.

To translate the rotary light motion into lateral motion, parallel to the dispersion plane, a "roof" mirror is employed. A light beam is reflected from the roof mirror whose edge is parallel to the dispersion or horizontal plane. It therefore serves as a plane mirror for light motion in the horizontal plane and eliminates vertical plane light motion by directing the light back on itself.

Wavelength scan interval is determined by the nutating-mirror tilt angle; wavelength scan midpoint is controlled by the roof-mirror tilt; instantaneous wavelength is a function of both angles.

In describing its system, P-E said that only rotational movement of elements is used. All forms of mechanical reciprocating motion were avoided in the design configuration. Scan frequency is not limited by mechanical resonance and dynamic balance is maintained constantly, regardless of tilt angle.

Because of this, said P-E, the scanning mechanism is capable of high frequencies and large wavelength intervals without noise and vibration.

• **Earlier work**—Actually, first work on this program started with a 50-day trial operation, following development and installation of the rapid scan system under a 1957 Air Force contract.

Results of the data reduction led to a one-year contract in July, 1959, for operation and data reduction of the system. (P-E also is training Radio Corporation of America personnel operating the AFMTC range in system use and maintenance.)

A new and larger rapid-scan unit will soon be used with a modified mobile ROTI Mark II facility. A 16-in. aperture is used and simultaneous radiometric and spectrometric measurements can be made.

Saturn Successor—Moon Roundtripper

NASA vehicle chief reports Nova remains top prospect, but nuclear upper-stage studies are being pushed

The vehicle to follow *Saturn* will have the mission of landing a manned 10,000-lb. spacecraft on the moon, reentering through the earth's atmosphere and landing safely.

This was disclosed by Maj. Gen. Don R. Ostrander, director of launch vehicles for the National Aeronautics and Space Administration, at the American Rocket Society Semi-Annual Meeting in Los Angeles last week.

Although *Nova* is still the leading possibility for the vehicle to follow *Saturn*, Ostrander said, the concept "is beginning to face increasing competition from vehicle studies with nuclear upper-stage rockets." For this reason, Ostrander continued, the Project *Rover* nuclear rocket is being accelerated, with the aim of an orbital flight test of a prototype by 1965, atop *Saturn* as a launch vehicle.

Ostrander's statement indicated support of the position of Harold B. Finger, NASA chief of nuclear engines, in the dispute over how the first *Rover* flight should be conducted. Finger favors first flight from orbit; Col. Jack L. Armstrong of the Atomic Energy Commission prefers a ground launching for the first test. However, Ostrander's statement did not rule out a ground-launched flight test in advance of the 1965 orbital flight.

NASA expects to contract with an industry group for a detailed study of all the factors involved in the test program question. A bidders' conference on the contract was held early this month. The study is expected to take about a year.

• **Permutations**—Ostrander emphasized that the *Nova* vehicle configuration has not yet been established. Several concepts based on the Rocketdyne 1½-million-lb.-thrust single-chamber engine are under consideration, he said. As one example, he mentioned the "brute force" approach of clustering six F-1's to produce nine million lbs. of thrust. "Four hydrogen-oxygen stages could be piled on top of this to give us the 10,000-lb. lunar return package that we need," he remarked.

Also known to be under consideration is a central F-1 surrounded by a circle of smaller H-1 engines, which might generate up to three million lbs. of thrust and be developed sooner. Other combinations of F-1 and H-1 engines obviously are possible.

On the other hand, Ostrander declared, the encouraging results from the *Kiwi-A* last summer "have stimulated our hopes that the large increase

in efficiency which we get from using one or more nuclear upper stages, with weights less than one-third that of the *Nova* for the same mission capability, can be acquired by the time our program has reached the point where we need something beyond *Saturn*."

• **According to plan**—As for *Saturn* itself, Ostrander declared that the second stage of the second *C-2* model will be a cluster of four 200,000-lb.-thrust hydrogen-oxygen engines. Apparently, NASA plans to stick with its original plan on the *C-2* stage. There had been some talk in recent weeks that the stage would consist of only two 200K engines.

Ostrander raised doubt whether the 2x200K stage would ever be built. He mentioned previously announced plans to use such a stage in the third model of *Saturn*—designated *C-3*—"if we decide to build it."

Centaur, the first vehicle to utilize a hydrogen upper stage, will be launched late in 1961, Ostrander declared. Atop an *Atlas, Centaur* will be able to put a payload of almost 8000 lbs. in low orbit, about 50% more than the *Atlas* with *Agena-B*, an upper stage of comparable size with more conventional propellants.

Centaur will have three times as much payload as *Atlas-Agena B* when used as a lunar probe, "which is one of its principal missions in the NASA program. For the first time, in *Centaur*, the U.S. has a launch vehicle able to duplicate the payload capability of the *Sputnik* vehicle."

Apparently, the U.S. will be able to duplicate *Sputnik's* lifting power just about four years after *Sputnik I*.

Ostrander recalled that *Centaur* is of prime interest to the Department of Defense as well as NASA, since the *Centaur* performance objectives stemmed originally from DOD requirements for a 24-hour communications satellite. NASA is interested especially because the *Centaur*, slightly modified, becomes the final stage of *Saturn*.

Vehicle Schedule

Vehicle	Time	In use	Payload (300-mi. orbit)
Jupiter-C		1958	25 lbs.
Vanguard		1958-59	25 lbs.
Juno II		1959-60	100 lbs.
Thor-Able		1958-60	200 lbs.
Thor-Delta		1960-62	480 lbs.
Scout		1960-69	200 lbs.
Thor Agena B		1961-69	1250 lbs.
Atlas Agena B		1961-66	5300 lbs.
Atlas-Centaur		1961-69	8000 lbs.
Saturn C-1		1963-?	22,000 lbs.
Saturn C-2		1966-?	45,000 lbs.
Saturn-nuclear		?	72,000 lbs.
Nova (9,000,000-lb.-thrust version)		1968-?	150,000 lbs.

'Blasts' in Lab

High-altitude Nuclear Shots Simulated by AF

High-altitude nuclear detonations have moved into the laboratory at Kirtland Air Force Base, N.M.

Certain aspects of such detonations can be studied by "dumping" electrical energy into test material specimens at the ARDC facility. Four low inductance condensors store as much as 16,000 joules of electrical energy at 125,000 volts. The chamber can be evacuated to simulate various altitudes.

One minute is required to charge the condensers which can then discharge in about one half a microsecond. Peak power during this instant of time is estimated to reach 10 billion watts. High-speed cameras, a Kerr cell camera and a streak camera record certain phenomena which the Air Force can correlate with high-altitude weapon detonations.

Spectral measurements of the test material and the heated air in the vicinity are made by an optically fast spectrograph. The $250,000 facility was constructed by Edgerton, Germeshausen and Grier, Inc., Boston, Mass.

We've reserved SPACE for the E

How do you meet a man traveling 18,000 miles an hour, 500 miles from earth? Northrop is already preparing for the next big challenge after the first human penetration of space, namely, rendezvous of men in space.

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Avco Reports Promising Two-day Test of Arc-Jet

WILMINGTON, MASS.—A 30-kw arc-jet engine, developing enough thrust to keep a communication satellite on station or to shift orbital altitude, has just undergone a 47-hour test at Avco's Research and Advanced Development Division.

The experimental space engine—about the size of a quart bottle—operated in a near vacuum using helium as a working fluid. It produced nearly ¾ lb. of thrust at specific impulse of 1000 sec. Total velocity increase for a 1000-lb. orbiting space vehicle was calculated to be about 4000 ft./sec.

According to James R. Kerr, president of Avco RAD, "the results of this test indicate that a reliable long-duration, one-pound-thrust, thermal arc engine can be made, and soon."

A complete propulsion system would consist of the engine, an electric power supply, and a tank of liquid hydrogen. A propulsion system of this sort lifted into satellite orbit by chemical rockets has a variety of possible applications in the exploration of space.

Thrust and acceleration of the arc-jet engine is small. They may operate continuously for hours or days, however, to provide a continuous force on a satellite that would result in steady acceleration and eventual very high speeds. Operation for short periods of time would be sufficient to make corrective changes in the attitude or position of communication satellites. Hundreds of hours' operation might carry the satellite from a low-altitude earth orbit into an orbit around the moon in constantly expanding spiral.

The recent 47-hour test is part of an Avco program to explore problems of a long-duration run, such as electrode erosion and cooling of the nozzle in a space environment. Reliability of components and simplicity of the system are the primary goals.

Say 3-Man Space Station Can Be Built in 6 Years

A space station manned by three men could be placed in orbit in six years at a total cost of $900 million, according to studies by two Chance Vought engineers.

Robert H. Lundberg and Tom E. Dolan last week outlined a program for orbiting a 4340-lb. satellite laboratory coupled with a 5750-lb. re-entry vehicle for the return trip to earth. The station would carry 673 lbs. of test payload and 583 lbs. of provisions, in addition to the three men. Two arrays of solar cells would provide 5.5 kilowatts of electrical power.

The two said the plan could be carried out within a balanced national budget. The cost would not be more than $300 million in any one year.

They named the space station "Satellab." Both Satellab and re-entry vehicle would be propelled by a *Saturn* launch vehicle into a 300-mile orbit. The re-entry vehicle would return to earth after the crew had completed the work of setting up an automatic station. For a subsequent manned mission, the crew would be sent up in an entry vehicle to rendezvous with the Satellab.

Lundberg and Dolan said the preparations leading to the first mission would require six *Atlas* boosters for sub-orbital qualification of the re-entry vehicle and pilot training, 11 *Atlas-Centaur* vehicles for orbital qualification of the entry vehicle and Satellab as separate elements and four *Saturns* for testing and launching the entire assembly. Altogether, 17 entry vehicles and nine Satellabs would be needed for the entire program, they said.

Nearly three-fourths of the overall expenditure would be in non-recurring costs, Lundberg and Dolan said.

Small Arms Fire Fails To Detonate Propellant

Nitrasol propellant will not detonate when struck by small arms fire, Grand Central Rocket Co. reported last week.

The company reported this conclusion from a series of gun-fire and concussion tests. Armor-piercing and soft-nosed bullets were fired into about 4 lbs. of uncontained propellant. Then the projectiles were fired into Nitrasol in a steel container. No detonation took place in any of the cases, the company said.

"These sensitivity and concussion tests assure that for the first time a high-energy propellant may be used by military troops with the same degree of safety as they now have with conventional explosives and ammunition," said G. R. Makepeace, GCR vice president for research and engineering. "Tactical missiles of the *Redeye* and *Mauler* type, *ICBM's* and very large solid propellant boosters loaded with Nitrasol may be employed safely by field commands."

Electronic Control Seen For Continuous Mixing

Rocketdyne is studying the possible tie-in of its Quickmix continuous solid-propellant processing system and electronic data equipment.

R. S. Dobyns, general supervisor of operations and methods at Rocketdyne's McGregor, Tex., plant, reported this last week at the 11th annual conference of the American Institute of Industrial Engineers in Dallas. He said such a system would offer completely automated control of processing and make possible improvements in uniformity.

NASA's

2nd, 3rd, 4th generation space rockets

To go vastly greater distances . . . to send heavier payloads . . . NASA scientists and engineers are working on the Centaur, Saturn and the Nova type vehicle. As the curve of scientific progress approaches the vertical, these advanced rocket boosters may bring significant breakthroughs in space exploration.

CENTAUR—the first rocket booster to be fueled with liquid hydrogen—will enable NASA scientists and engineers to put four-ton payloads into 300-mile orbits around the earth.

SATURN—initiated by Defense Department and now transferred to NASA, the 1.5 million pound thrust booster will place 15-ton payloads in orbit. Such a payload could be a manned space observatory.

NOVA TYPE—a cluster of single chamber 1.5 million pound thrust engines now being developed to launch multi-ton space stations or to send manned expeditions to the moon.

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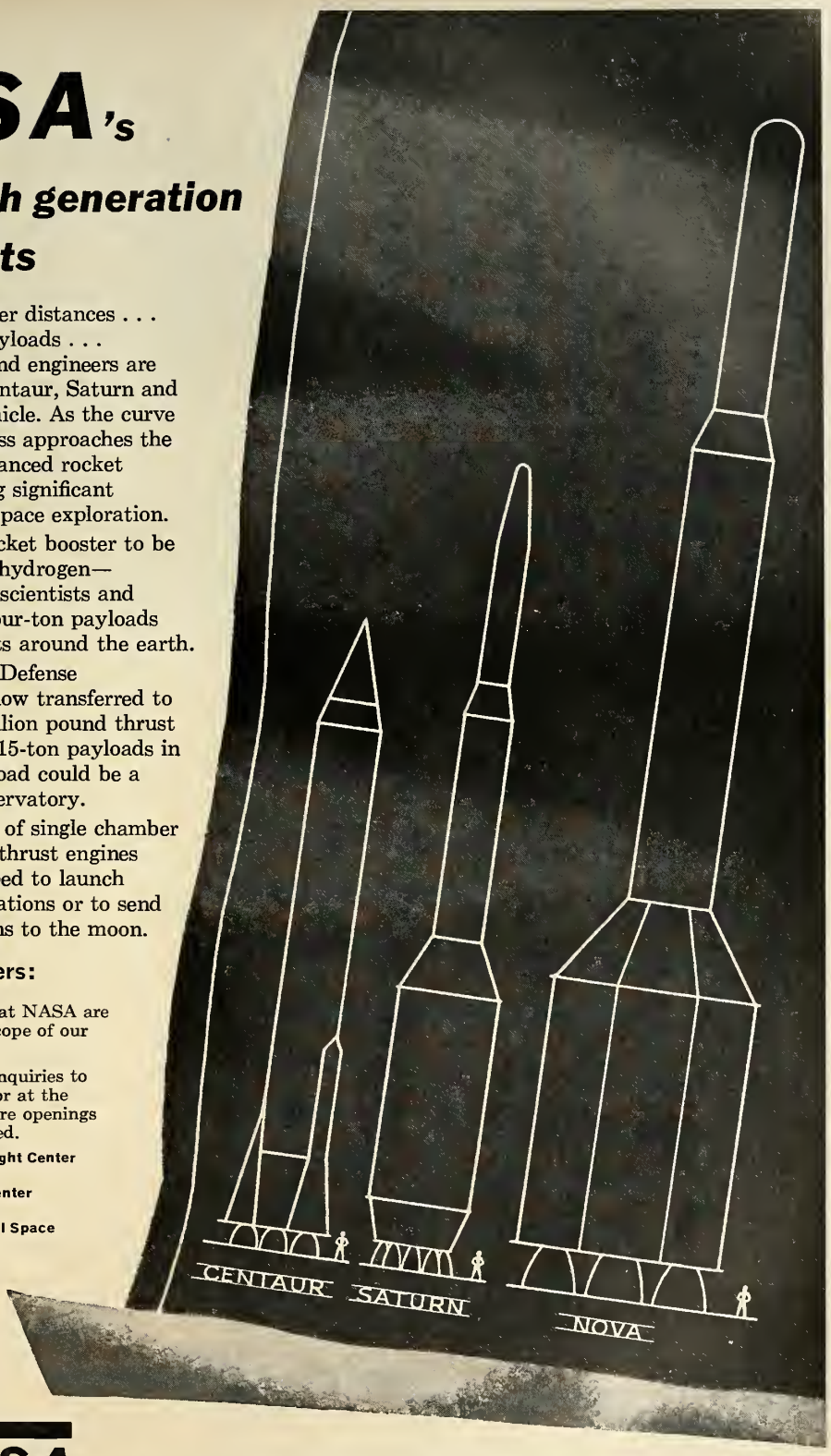


NASA National Aeronautics and Space Administration

Space Stations May be Made of Spheres

by John F. Judge

PHILADELPHIA—Space stations may well be constructed from a series of intersecting spheres rather than the cylindrical doughnut configurations being advanced today.

Norris F. Dow, structural specialist at General Electric's Missile and Space Vehicle Department, says that from the standpoint of weight savings and structural efficiency, spheres or a series of them are the logical components of a space station.

Dow says the main design considerations are: internal pressure, meteoroid impacts, explosive decompression and radiation shielding.

If, as has been indicated, rocket fuel tanks double as space cabins, pressure vessel design may be the most important single structural aspect. Using the fact that the ratio of weight of a pressure vessel to the enclosed volume is a constant, for given stress and pressure levels and for geometrically similar vessels, Dow says that the weight of wall material to enclose a given volume at a given pressure in one sphere, or a multiplicity of spheres, is the same.

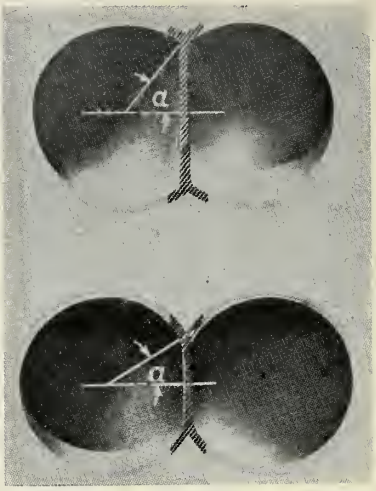
It has been shown that the weight of a long, thin-walled cylinder approaches 1.33 times that of the sphere as the length approaches infinity. Dow points out that the potential efficiency of intersecting spheres may be as much as 1.33 times that of a cylinder.

• **How to exploit**—To take advantage of the possible weight saving in spheres, the weight of the intersectional bulkheads, the geometrical relationships (diameters, frontal areas, surface areas) and the effects of bi-axial stresses must be examined.

Dow says that if the angle of intersection is kept to less than 30°, about 66% of the weight savings associated with single spheres may be achieved with intersecting spheres. The amount of material in the intersection is governed by the angle of intersection.

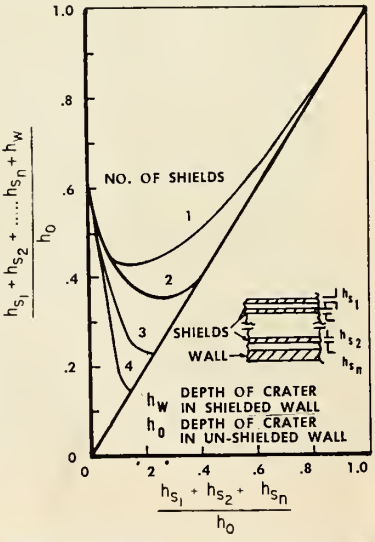
If outside diameter, frontal area and surface area are critical, the intersecting sphere concept should not be used, says Dow. But these factors are much less crucial than the weight in space stations.

No material prone to weakness from bi-axial stress conditions can be used. This, according to Dow, eliminates such items as uni-directionally-reinforced fiberglass plastics.



REPRESENTATION of angle of intersection (a), and approximate zone of material involved in the joint between intersecting spheres.

Multiple shields may be incorporated into the design as far as practicable for protection against meteor impact. This means of shielding would seem more effective than the Whipple double wall concept, says Dow. This area needs more experimental analysis before firm conclusions can be drawn.



EFFECTIVENESS of multiple walls against meteoroid penetration.

• **Meteor hits**—The possibility of penetration by a large meteor must also be taken into consideration. One way to avoid explosive decompression in such a case is to design the wall so thick that stress levels introduced by a puncture would not be critical. Another approach is to include stiffening rings.

Dow says that if the vehicle is to be designed for the lowest possible static safety factor with the least weight, then stiffening rings are the answer. But conservative design on a static strength basis would mean utilizing the inherent overstrength of the shield itself to prevent crack propagation from meteors—instead of stiffening rings.

Dow says data indicates that the use of adequate rings will make the size of the puncture non-critical, whereas a big enough hole will burst any unstiffened shell. In addition, no consideration has been given to the possibility of a ring being pierced. This factor must be accounted for in the final analysis.

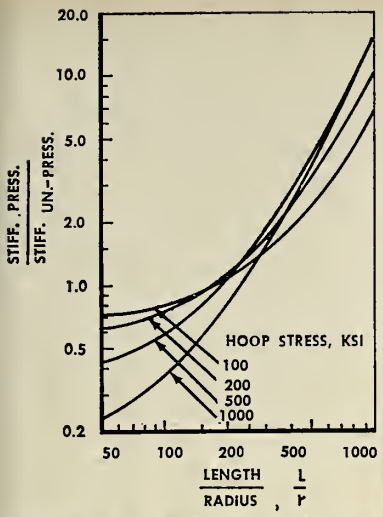
• **Lead satellites?**—According to Dow, if radiation shielding requirements degenerate to walls weighing about 25 lbs. per square foot—weight savings could be attained by reducing the surface area or putting everything on board against the walls.

A sphere has the least surface area for a given volume and thus would contain the greatest volume with the least wall weight if the wall material is fixed.

The toroid seems to be the most popular configuration for space stations. Dow says that spheres lend themselves to toroidal shapes without losing any of their inherent advantages. Spheres can be intersected to complete a toroid or a single sphere can be counterweighted (sphere on a string) and revolved to provide artificial gravity.

The counterweight concept is not prohibitive, says Dow. If nuclear reactors are used, its placement at the end of a cable, far from the cabin, would serve the dual purpose of providing counterweight and distance from the reactor's radiation.

In the matter of supporting antennas, reflectors or other members



RATIOS OF stiffness of air pressurized Al-alloy, cantilever beams of circular cross-section to ratios of stiffness for similar unpressurized beams.

extended from space vehicles Dow advocates the use of pressurized tapered beams. The internal pressure of a gas will increase the stiffness of an "outrigger"—by an order of magnitude for very long beams.

Dow says the extent of the influence of structural consideration in over-all space vehicle configurations is readily appreciated if the design is aimed at space environments rather than simply load supporting members.

Latest Univac Called Lowest-cost Computer

"The lowest-cost computing system available in terms of cost per unit of output," is how Remington Rand's Univac Division describes its new Univac III.

Renting for from $15-30 thousand/month, depending on user requirements the system is all solid-state and reported to be nine times faster than its predecessor. Operating efficiency is up 25% over existing EDP systems, said the company.

Other vital statistics include: 200,000-digit/sec. processing rate; 16384-word magnetic core memories; magnetic-tape or punched-card operation with a 700-card/min. reader; 700-line/min. printer. A program-interrupt feature indicates to the computer that its peripheral equipment has performed a particular task and is then ready to accept another.

Input and output of data is five times faster than that of Univac II, said the company, and reading, writing, and computing operations are performed simultaneously.

NBS Moves to Develop Ultraprecise Gage Blocks

The National Bureau of Standards is acting to meet the ever-stricter demands of the Space Age by developing gage blocks which can provide measurements precise to 1 part per million over extended time periods.

These blocks are used to monitor manufacturing processes in mass production of interchangeable machined parts in tools, ball bearings and missile control mechanisms. The extremely high dimensional accuracy required by missile/space technology means that gage blocks certified to 1 or 2 parts in 10 million will have to be available soon—and on a regular basis.

Under a special program at NBS, supported by major missile/space manufacturers, M. R. Meyerson of the Bureau's metallurgical laboratories has produced blocks with dimensional stability considerably greater than commercial blocks, but work is continuing to develop standards that will retain their calibrated lengths to extreme accuracy over long periods.

• **Problems & approaches**—Besides shrinkage and growth problems, the development program must cope with such complicating factors as appropriate coeffecient of thermal expansion, high degrees of surface finish, flatness of surface, parallelism of opposite gaging faces, resistance to wear, deformation, and atmospheric and fingerprint corrosion.

Metallurgical methods employed in the improvement studies included elimination of unstable constituents in hardened steels and reduction of fabrication stresses. Other techniques involved nitriding, chrome-plating, tungsten carbide and aluminum oxide coatings, spraying with nickel-chromium-boron alloy and case hardening through processes of carbonitriding, carburizing and cyanide hardening.

Annealed 410 stainless steel blocks with nitrided surfaces have been made which exhibit a growth of only 0.0000002 in. per in. per year during the first year of observation. 52100 steel gage blocks displaying a shrinkage of 0.0000004 in. per in. per year have been produced through special stabilizing and stress relieving treatments.

Stability evaluations at the Bureau involve two types of measurements—static comparisons carried out interferometrically and dynamic comparisons which rely on a mechanical electronic technique.

A block must pass rigid surface flatness and gaging face parallelism tests before it is admitted to the stability runs.

UNSYMMETRICAL thermal effects were produced when gage blocks were gripped as in the top illustration. NBS experts found that this was eliminated when the non-gaging edges were facing the palm as in the lower photo.

The measurement data taken is reduced by least squares to provide a calculated value for each comparison. The probable precision of results is determined by plotting the magnitude of each residual (the difference between the calculated and the observed value) against the number of times it occurred. This procedure, termed frequency distribution, is used in establishing the relationship between calculated probable error and actually realized precision, in demonstrating the successful elimination of bias from comparison procedures and in locating sources of systematic error.

• **Palm reading**—The Bureau found that residual frequency was effective in prescribing a handling procedure. In the manual handling of blocks by operators wearing insulated gloves, the blocks were picked up by their non-gaging ends in comparison pairs and positioned in the comparator in what was thought to be symmetrical handling. But it was found that the handling was producing an unsymmetrical thermal effect—the blocks were held perpendicularly so that one was nearer the operator's palm .than the other. When the blocks were picked up with their non-gaging ends facing the palm, the statistical distributions showed the expected symmetry.

Blocks of 410 stainless and 52100 modified steel have been observed for a year. There are 14 other materials under study at the bureau. The most stable blocks were of nitrided 410, ground, stress relieved and lapped. The 52100 blocks were not quite as stable but most of the variations occurred during the first six months of observation. These blocks were processed through heat and chill treatments and stress relieved.

Commercial (AA grade) blocks, purchased from various manufacturers were run through the stability tests. They became shorter, averaging 0.0000011 in. per in. per year.

The importance of this program is illustrated by the support of firms such as General Electric, du Pont, Hughes Aircraft, Pratt & Whitney, Link Aviation, IBM, Brown & Sharp, New Departure, The Sheffield Corp., Timken Roller Bearing and others.

High Temperature Al Parts Impact Extruded at ALCOA

Precision aluminum parts useful up to 900°F—almost 400 degrees higher than the usual operating temperatures—is the result of a powder metallurgy impact extrusion development at Aluminum Company of America.

The parts are formed through a series of operations that begin with powdered aluminum. The powder is compacted and sintered into a billet which is in turn, hydraulically extruded as a rod. The rod is then cut into slugs for the impact extrusion process.

The working of the metal in the impact extrusion adds significantly to the physical properties of the part. A small ¼ in.-diameter finned tube has been impacted in lengths up to 14 ft. at ALCOA's Edgewater, N.J., works. This finned prototype is being evaluated for an atomic energy application.

Company spokesmen add that other small parts are undergoing examination for missile purposes. Secondary metal components such as actuating cylinders and collector caps for hydraulic cylinders are examples of the areas of elevated temperature environments in which impacted parts may be useful.

The range of applicability of the APM impact method is as wide as the basic impact process itself. Normal maximum and minimum size limits for impacts apply and tolerances within 0.0025 in. have been achieved.

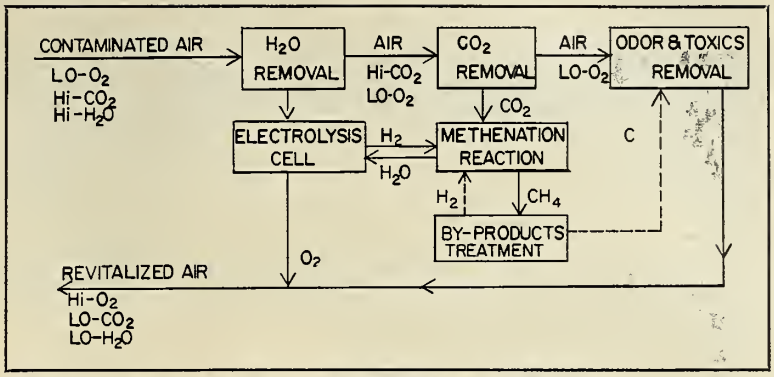
Synthesis Best for Long O_2 Recovery

The "Fischer-Tropsch Synthesis" ystem rates tops among the feasible ays to supply man with purified air n an extended space flight, according o John Konikoff, of General Electric's Missile and Space Vehicle department.

Konikoff told the Aerospace Medial Association Meeting in Miami each earlier this month that such a ystem would be better than a stored-xygen system for space flights of ore than 26 days.

In this synthesis system, carbon dixide is reduced by hydrogen to form ater and methane. The water is then ecomposed electrically to release oxyen for re-use by man. Weighing as litle as 120 pounds, the system could be uilt to supply one man's oxygen needs space indefinitely, according to Koikoff.

Other advantages stated are that he methane produced could be used s a fuel; that all reactions in the system are at atmospheric pressure; and that the energy needed to operate the system could be supplied by the sun, a fuel cell, or by other devices being developed.



BLOCK DIAGRAM of Fischer-Tropsch Synthesis for oxygen recovery.

On the basis of weight and simplicity, a stored-oxygen system would be best for a space flight up to 16 days, said Konikoff. A superoxide system would be best for from 16 to about 18 days. A liquid oxygen system would operate best from 18 to 26 days, and the regenerative Fischer-Tropsch would be best indefinitely after 26 days.

Man Lives on Algae-derived Oxygen

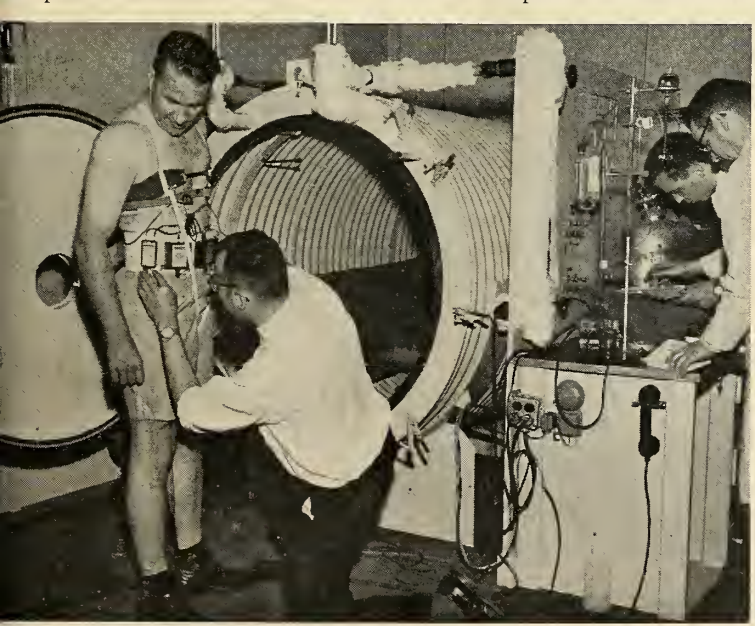
For six hours Boeing scientist omney H. Lowry, M.D., worked in a ealed capsule where his only oxygen ame from growing green algae, the ompany reported recently. The man's eactions were monitored by Boeing-eveloped miniature instruments which were worn on a belt around his waist and powered by a miniature battery.

Ultimate aim of the experiment is to create a packaged closed circuit environment for space travelers.

Lowry is said to be the first man who has ever spent several hours in an environment whose oxygen was totally regenerated by algae. Without the help of this microscopic water plant, the scientist would shortly have been asphixiated by his own exhaled carbon dioxide.

Belt-worn physiological instruments, each occupying a volume about equal to that of a package of cigarettes, include miniature electrocardiographs, phonocardiographs, respirometers, electroencephalographs and electronic equipment for measuring body temperature. Results are said to be equivalent to those of standard size instruments. Other physiological equipment Boeing says it is developing will measure blood pressure and autonomic responses.

Boeing emphasizes that its present instruments are designed for laboratory work. They are packaged to operate with temperatures ranging between –40°F and 110°F, with static acceleration up to 1g and vibration up to 5g and 500 cps.



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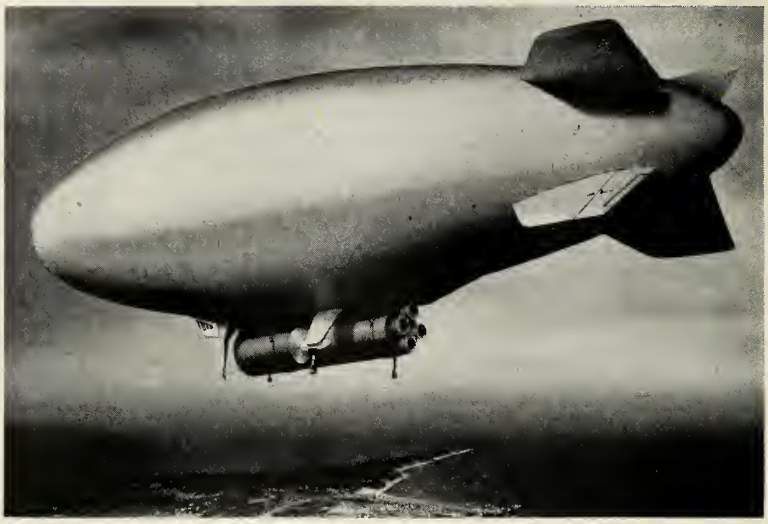
BOEING RESEARCHER Romney H. Lowry, M.D., watches last-minute adjustment of physiological sensors before he enters sealed capsule for six-hour stay in atmosphere whose oxygen comes only from algae.

Blimps Can Haul Huge Boosters



Non-rigid airships could easily solve the problem of transporting huge rocket boosters from factory to launch pads, contends Goodyear Aircraft Corp.

Following up on earlier claims for the blimp carrier, GAC recently concluded a feasibility study of the logistics problem involved in the increasing size of boosters being developed for space exploration.

It now reports that airships ranging in size from 1.5 to 5 million cubic feet could haul present and future boosters without difficulty. One capable of handling the *Saturn* booster would be 563 ft. long and is considered to be well within present state of the art.

Advantages of blimp transport stressed by the GAC study:

- Operation independent of tunnels, trestles, waterways and highway clearances.
- Point-to-point deliveries out of and into small fields.
- Elimination of the necessity for tractor-trailers, ships, and barges.
- Smooth operation with little possibility of damage to sensitive components.
- Practically unlimited range within U.S. or even overseas.

By modification of the cabin structure and addition of a cargo suspension system, existing models could carry boosters 25 ft. in diameter, 80 ft. long, and weighing 15 tons. A 5-million cubic foot airship—of *Saturn*-booster capacity—would be only 40% larger than present types. According to Goodyear, such a craft could transport a 55-ton load 2000 miles nonstop.

Ground facilities for the airships could be very simple. Only a relatively smooth field less than a half-mile in length, two tractors, and a portable mooring mast would be required.

The Goodyear report cited the difficulties already being experienced in hauling boosters over highways. Even those only 10 ft. in diameter require trailers that almost cover a two-lane highway. Those now in the planning stage will be too big for existing highways, railroads, and airplanes to handle. Railroads and trucks are limited by roadway clearances, airplanes by size of cargo compartments, and ships and barges by lack of waterways to factories and launch sites.

Largest TE Generator Built by Westinghouse

A five-kilowatt thermoelectric (TE) generator—The most powerful ever built—has been developed by Westinghouse Electric Corp. for the Navy's Bureau of Ships.

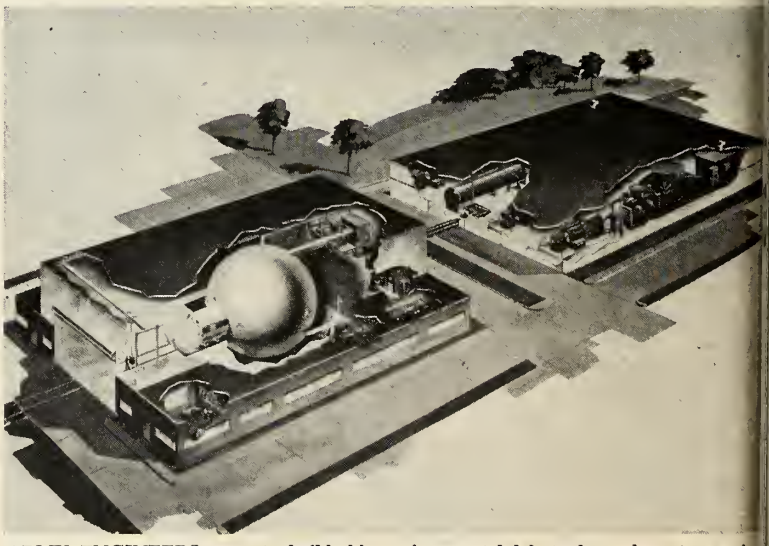
The generator directly converts heat into electricity without any major moving parts. It is 50 times more powerful than any previous TE powerplant, and delivers enough electricity to light eight to ten average homes at the same time.

The new development is an experimental unit intended for evaluation of power-generating materials and fabrication techniques produced under a Navy-sponsored TE materials research program.

New Materials developed by this program have reportedly tripled in the last three years the efficiency with which heat may be directly converted to electricity.

In announcing that the generator had undergone its first full-power tests, Dr. S. W. Herwald, Westinghouse vice president in charge of research, described its development as "a significant advance in the thermoelectric art."

Army Lunar Simulator Concept



ARMY ENGINEERS want to build this environmental lab to learn how to survive on the moon. Lab would reproduce temperatures, radiation and vacuum conditions.

TWO DECADES OF LEADERSHIP IN CRYOGENICS

1945

Development of first low-pressure helium liquefier. The ADL-Collins Helium Cryostat is the prime tool for 95% of the free world's research in cryogenic science.[1]

1947

Development of the first high capacity air-transportable liquid oxygen generator for missile application.

1958

World's first superconducting computer built and operated at ADL's Acorn Park Laboratory.[2]

Arthur D. Little, Inc.

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Copies of the literature below may be obtained from Director of Public Relations, 74 Acorn Park, Cambridge, Mass., or from ADL Sonto Monica Engineering, 1424 Fourth Street, Santa Monica, California

- ☐ [1]The ADL-Callins Helium Cryostat
- ☐ "Cryagenics — Fertile Fields Ahead," A. Latham, Jr., D. C. Bawersack, and B. M. Bailey, *Chemical and Engineering News*, August, 1959
- ☐ "A New Low-Temperature Gas Expansian Cycle" (Parts I and II) H. O. McMahon and W. E. Giffard, 1959 Cryogenic Engineering Canference
- ☐ [2]"A Cryotran Cotalog Memary System," A. E. Slade and H. O. McMahon, Eastern Jaint Camputer Canference, 1957
- ☐ "Test-Tube Titan," J. R. Elliott, *Barron's*, December, 1959

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BMEWS WILL DETECT oncoming ICBM's by sending R-F energy out into space at two and five degrees.

First BMEWS Site Nears Operation

by Donald E. Perry

THULE, GREENLAND—Construction of the first of three sites of the ballistic missile early warning system (474L) here is virtually complete, and the station is due to start radiating energy into space on fully operational status this fall.

Testing of equipment and marriage of subsystems of this, the free world's largest radar installation, began in April and is on schedule. Full power from one transmitter module was beamed into space for the first time in early April and has been on the air "several" times to date.

The nearly $1-billion BMEWS Program, designed to give southern Canada and the United States 15-24 minutes warning in event of a mass ballistic missile attack from the Soviet Union, will have two other stations. One will be at Clear, Alaska, and the other at Fylingdales Moor, in Yorkshire, England. The Clear station, already under construction with foundations and other basic work complete, will become operational in the summer of 1961. The U.K. station should follow in 1962.

U.K. station will cost about $115 million, with the British assuming $25 to $30 million (mostly brick and mortar) and the U.S. furnishing electronic equipment. Clear station will cost about $328 million. Cost of the Thule station, opened for the first press inspection last week, will be $500 million. Total program outlay will be $952 million, including $9 million for a world-wide program equipment display at North American Air Defense Command (NORAD) in Colorado Springs. Yearly system operating costs will approximate $110 million.

Each site ultimately will include radars, a missile impact prediction computer, checkout and switching equipment, checkout and monitoring equipment, a data link to NORAD, plus monitoring equipment at Strategic Air Command (SAC) headquarters in Omaha.

• **Organization**—This cooperative effort involves not only four governments—the U.S., Canada, Great Britain and Denmark—but the Air Force, Army, Navy and an industrial team of 2900 large and small missile/space industry suppliers located in 29 states. Some 66% of BMEWS is subcontracted with about 36% going to small business.

Army Corps of Engineers is responsible for site construction and Navy's Transport Service is shipping major portions of equipment and construction materials.

While the AF BMEWS project office at Lawrence G. Hanscom Field in Bedford, Mass., directs the entire project in its electronic systems center of Air Materiel Command, Radio Corporation of America is prime system contractor. RCA last week was awarded a continuation contract for implementation of the Yorkshire site.

The Project office contains elements of AMC acting as executive agent, and Air Research and Development Command to achieve proper phasing of actions in development, procurement, production, maintenance and supply. The Electronic Systems Center is not building up technical in-house capability but is strengthening its management position, relying on industry as the backbone for this electronic gargantua.

Reliability in all equipment has been the by-word since the start of the program, carried on with urgency since *Sputnik I.* It is being achieved in three ways. First, equipment is being designed to require minimum repairs and still allow the fastest possible maintenance. Second, duplicate equipment is being installed in many areas to compensate for anticipated down time and to insure round-the-clock operation. Finally, an elaborate system of control and switching equipment and checkout and automatic monitoring equipment is permitting a thorough analysis and flexible interchange of units during operation. Such analysis should allow preventive maintenance to forestall serious down time following an equipment failure. Components are allowed to work only at 40% maximum military specs.

• **Special problem**—Arctic elements have posed innumerable problems. Four 165-ft. high, 400-ft. long antennas of nickel steel (for ductility) have to withstand 185-mph winds, temperatures that can dip below —65°F, and ice six inches in thickness which can dou-

ble the weight of the 1500-ton D.S. Kennedy & Co. reflectors.

There is nothing simple about construction in Thule, where excavations must be drilled and shot to penetrate permafrost known to reach a depth of 1200 ft. Even refrigeration coils have to be placed in the ground beneath some buildings to prevent melting of the active top-five-foot permafrost layer and subsequent settling of the buildings either during curing of the concrete floors or later while they are in operational use.

One of the biggest problems RCA had to face in this installation was the technical integration of thousands of components into subsystems and tying those in overall, while at the same time building in fault-finding equipment to keep the site under continuous operation. (See table.)

To accomplish its system contractor task, RCA has kept close coordination over more than 10,000 people employed in the industrial team. RCA alone has some 800 systems management-type personnel working with AF BMEWS project office. Some 850 well-trained BMEWS engineers, technicians, administrative and other personnel of RCA, its subcontractors and AF, now are at Thule. RCA personnel are scheduled to man this site for at least another year until AF technicians now in training will take over. Contractor personnel have a 70-hour work week (time and a half for over 40 hours) and get incentive pay, free lodging and meals. While incentive pay varies, it approximates 30%.

• **Concurrency demand**—Scheduling has been a formidable task, not only because of its size and the tremendous number of people involved, but because development and production has had to be carried on concurrently.

Added to this has been the burdensome logistics and support factor with equipment having to be shipped at precisely the correct time because of the limited sea access to Thule. Waterways are open only three months a year and air shipments cost 10 times more than those by sea. In the face of this, however, military sea transport has sea-carried some 26,400 short tons of electronic equipment. A total of 150,082 measurement tons of all kinds of material have been transported to the site by sea and 3126 short tons by air since the Thule project got underway in early 1958.

While the Lincoln Laboratory-conceived BMEWS concept has been referred to as an "electronic Maginot line," it nevertheless today stands as a monument to teamwork with the military and industry welded together for a common defense goal: pushing the electronics state of the art and delivery of an operational system on schedule. To do it, design, assembly and testing have been almost parallel.

• **Limitations**—BMEWS will give no protection against the submarine-launched ballistic missile. It is questionable whether it is immune to jamming and even if it were, whether such jamming could be considered as a hostile act. It will, however, buy precious time in event of a mass missile attack. Time which can be used in getting SAC bombers into the air and alerting the civil populace. It later will complement the *Midas* infrared detecting satellite system, adding more minutes to our response time.

It lacks a lot of things. It's big. It's costly. It lacks precision tracking which would give more than just a regional indication of impact area. It's suffering from the perennial budget squeeze too.

Plans for two tracking radars each at Thule and Clear at a cost of $75 to $100 million have been shelved, at least temporarily. The U.K. site, however, will include three radar installations with 85-ft. diameter "dish"-style reflecting antennas performing both tracking and detection functions. Construction of this site is to begin shortly.

Prototypes of tracking radars are undergoing tests at RCA's Moorestown, N.J., facility. Goodyear Aircraft Corp., contractor for antennae and radomes, is putting another prototype through 24-hour life tests at its Akron facility.

• **Dimensions**—Tracking radar and its pedestal weighs nearly 375,000 pounds. The hydraulic, servo-driven rotating section comprises 200,000 pounds of this weight. It's designed for a 10-year Arctic life. The radome with a diameter of 140 ft., is seven stories high, has 1646 hexagonal sections each with a six-in. thickness of design-impregnated paper between fiberglass walls. The antenna is within ¼-in. of a true parabola. It can be slewed in azimuth at extremely high velocity.

Continental Electronics Manufacturing Co. is supplying tracking radar transmitters, although a parallel development program was carried out by RCA.

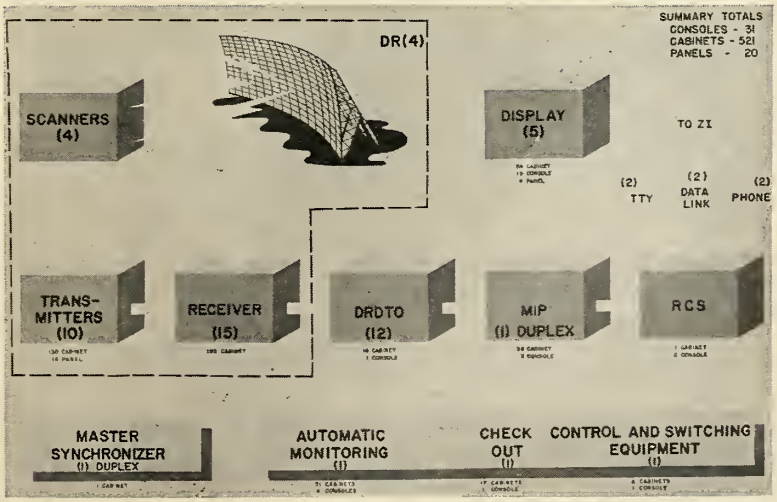
The BMEWS site is located on a 1200-ft. cliff about 12 miles northeast of Thule air base overlooking three glaciers. The 80% solid-state electronics facility receives prime power—69 kv—from a Navy power ship in Thule harbor. An alternate power system will be completed this summer. Overall facilities to house equipment were designed by Metcalf & Eddy, Boston A&E firm.

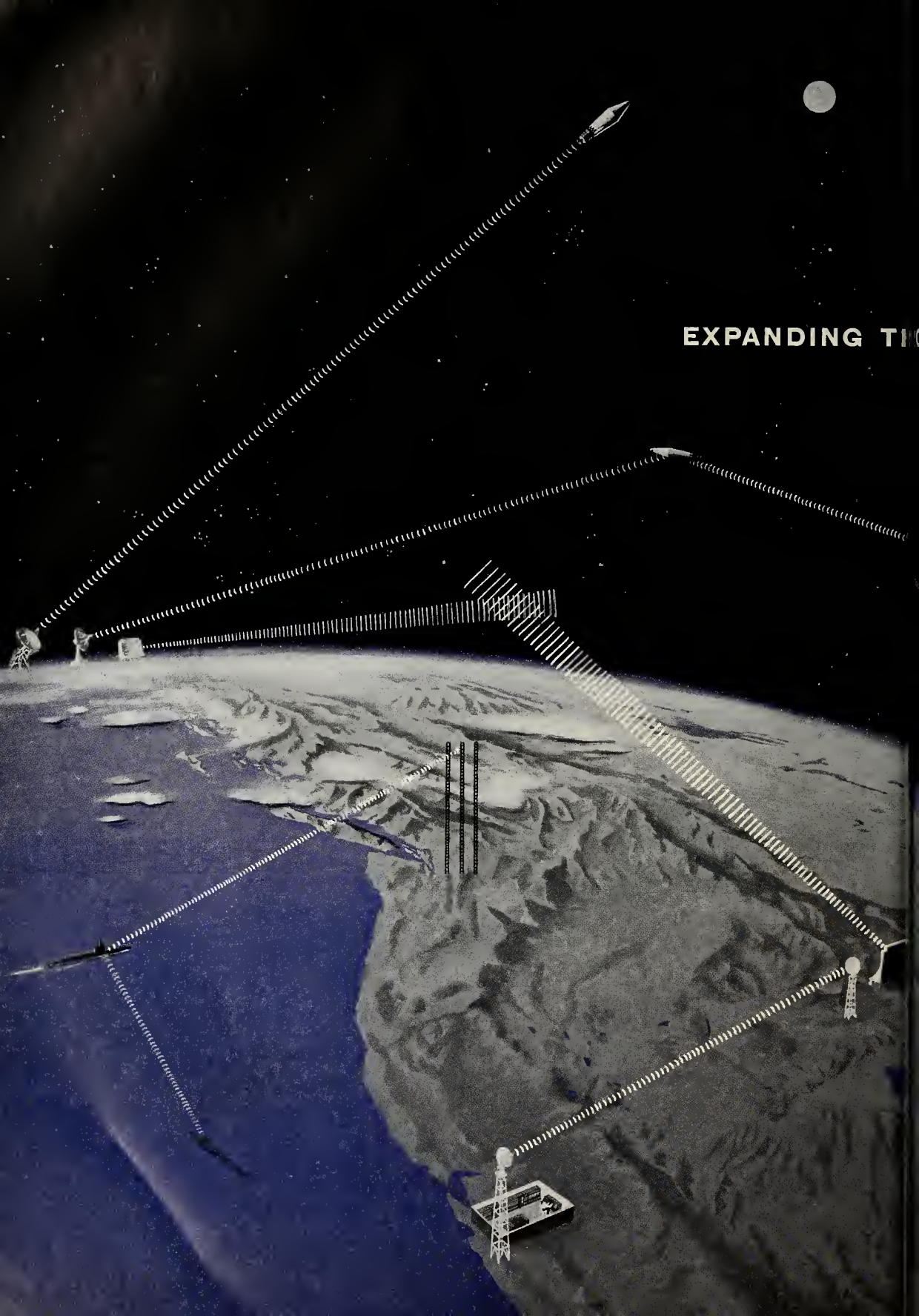
Four General Electric Heavy Military Electronics Department AN/FPS-50 pulsed doppler detection radars with a range of 3000 nautical miles each scan about 38 degrees for a total field coverage of about 150 degrees, including overlap. Each torus-shaped radar reflector radiates two horizontal fan-shaped beams at elevations of approximately two and ten degrees, forming two detection fans, one above the other. Impact prediction can be obtained by extrapolating the missile's path from the range, azimuth, bearing and time sequence data recorded as the missile passes through each of fans.

• **Discrimination**—The system has some discrimination capability such as distinguishing between satellites, missiles, meteors, auroral disturbances, solar and intra-terrestrial noise. GE made an examination of 191,500 separate trajectory coordinates and their relationships to establish discrimination parameters.

Some 290 cabinets are required to house radar equipment at the site. Ten transmitters are required for the RF

BMEWS Signal Flow at Site 1 (Thule)




EXPANDING TI

Herodotus, the historian, records (490 B.C.) the use of burnished shields for military signaling. This was the forerunner of the heliograph, invented by Sir Henry C. Mance, which came into wide use centuries later.

ONTIERS OF SPACE TECHNOLOGY IN

COMMUNICATIONS

Lockheed's interest in developing the science of communications extends from the depths of the oceans to deep space. Its Missiles and Space Division research programs deal with the development and application of statistical communication and decision theory in such areas as countermeasures; telemetry multiplexing and modulation; scatter communications; multiple vehicle tracking; millimeter wave generation and utilization; sonic signal detection and processing; avoidance of multipath degradation; and interference avoidance.

Associated research and development efforts are directed toward propagation studies and advanced antenna design; low noise amplifiers; vehicle borne signal transmission and reception, data storage and processing; solid state materials and devices.

The scope of such activities extends from advanced studies of naval communication problems on and under the oceans; the many applications to satellite vehicles; on to the specialized communication problems of deep space explorations. Latter needs are exemplified by high frequencies, low weight and power, high stability, low effective bandwidth, extreme reliability and basic simplicity requirements.

Engineers and Scientists: Investigating the entire spectrum of communications is typical of Lockheed Missiles and Space Division's broad diversification. The Division possesses complete capability in more than 40 areas of science and technology — from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; communications; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetohydrodynamics; man in space; materials and processes; applied mathematics; oceanography; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space medicine; space navigation; and space physics.

If you are experienced in work related to any of the above areas, you are invited to inquire into the interesting programs being conducted and planned at Lockheed. Write: Research and Development Staff, Dept. E-29B, 962 W.El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense clearance required.

Lockheed / **MISSILES AND SPACE DIVISION**

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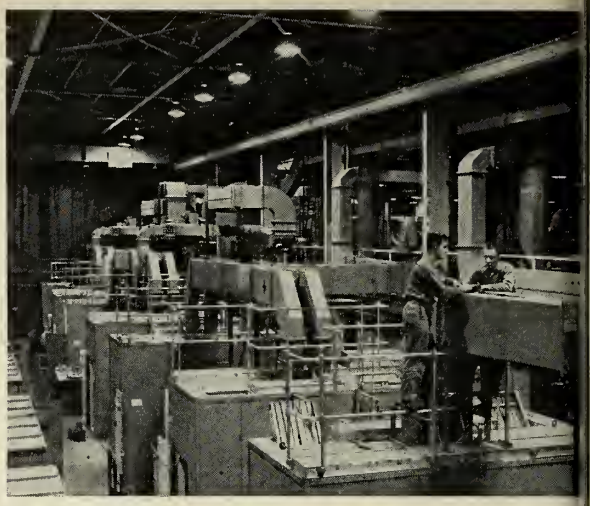
SOME 40 back stays and trusses each weighing seven tons are required to support surveillance radar at BMEWS Site 1.



GE TECHNICIANS inspect wave guides which carry R-F energy from transmitters to the scanner building at Thule site.

energy. Rectifiers each weigh 27 tons and provide over 100,000 volts DC.

A number of Varian Associates and Eitel-McCullough super-power klystrons are employed in the final amplification stage of the transmitter. Since they are some 10 ft. long and weigh around 600 pounds, chain hoists are provided in the transmitter buildings. There are some 440 miles of connecting cables. Reynolds Aluminum furnished 12 miles and Andrew Corp. the remainder of the wave guides. Eight high-powered General Bronze Co. scanning switches receive the radar energy which has been piped through the waveguides from the transmitter. They switch this power sequentially into other waveguide paths arranged around the switches.

Energy is directed through this array into a pattern resembling a church organ to some 704 Andrew Corp. feedhorns on the scanner buildings.

When a target passes through a radar fan, a signal measured in millimicro-microwatts of energy is reflected back to the antennas. Signals are then switched to receivers and amplified to a usable level. Next stop is the data cabinets where measurements are made to determine the exact points on the trajectory of the missile's path from the fans. Categorized data is channeled to the appropriate computer input circuit where differentiation of the target object is made.

• **DRDTO**—Detection radar data take-off (DRDTO) equipment supplied by Sylvania Electric products operates in conjunction with the radars. This equipment transforms analog radar returns into digital data for processing by two 7090 computers, first military operation for this commercial version. The equipment performs 200,000 mathematical operations per second, feeding the digital information into a missile impact prediction set (MIPS) computer for analysis. DRDTO also provides target discrimination by separating simultaneously observed objects so that target data may be recorded sequentially.

Tracking radar take off (TRDTO), when and if installed, will perform the intermediate data processing functions between each tracking radar and the MIPS computer. System will take advantage of RCA's development work on the AF *Wizard* project.

Checkout and automatic monitoring equipment should insure reliability through continuous monitoring mode and fast detection of trouble areas.

Western Electric Co., under a separate prime AF contract, is constructing the $84 million rearward communications system over some 45,000 route miles to NORAD and SAC combat operations centers. Design work was done by Bell Telephone Labs.

• **Combined methods**—Multiple communications methods — submarine cable, landcable, line-of-site microwave radio relay and advanced tropospheric scatter radio—are being used. A new tropo system has three sizes of transmitters, the largest to meet different conditions. Blaw-Knox and Canadian Vickers are supplying antennas of 60 and 120 ft.

One signal carries 63 separate pieces of information gleaned from the antennas. Each communication system transmits over two routes simultaneously as a safeguard against interruption due to deliberate or accidental damage to the circuits. Voice and teletypewriter circuits are available for backup.

As part of the program, Western Electric has laid the first dual (out and in) submarine cable in the Arctic circle. It links Thule with Cape Dyer, Baffin Island, 700 miles to the southeast across icy Baffin Bay. Submarine cable soon will be placed in the Davis Strait and the Atlantic Ocean, bridging a 1250-mile gap between Cape Dyer and Newfoundland. Repeaters, to amplify signals, are located about every 40 miles along the cable.

Seventeen commercial communications and government or military agencies in three countries are providing the rearward communications at more than 400 locations of which some 350 are on routes of commercial communications companies.

BMEWS Component Equipment Statistics (Estimated)

ITEM	SITE I	SITE II	SITE III	ZI	TOTAL
WAVEGUIDE	109,000 FT. (21 MILES)	81,000 FT. (15 MILES)	1,200 FT.	.....	191,000 FT. (36 MILES)
TRANSISTORS	315,000	297,000	139,000	30,000	780,000
TUBES	33,000	32,000	100,000	110	165,000
CAPACITORS	267,000	260,000	310,000	12,000	849,000
RESISTORS	1,080,000	978,000	429,000	33,000	2,520,100
EQUIPMENT RACKS	818	664	590	27	2,099
CABLING	1,580,000 (300 MILES)	1,360,000 (260 MILES)	1,260,000 (240 MILES)	60,000 (12 MILES)	4,260,100 (800 MILES)
INTERNAL WIRING	1,375 MILES	1,090 MILES	750 MILES	45 MILES	3,260 MILES
SOLDERED AND CRIMPED CONNECTIONS	14,000,000	11,500,000	10,000,000	500,000	36,000,000
TONNAGE OF EQUIPMENT	26,400 S/T	17,300 S/T	6,500 S/T	1,400 S/T	51,600 S/T

Echo Failure Sets Program Back Six Months to a Year

The United States' passive communication satellite program has been set back six months to a year, with the May 13 failure of an *Echo* launch.

As with many NASA projects, the *Echo* attempt had no backup, and the next scheduled *Echo* shot, according to NASA testimony before Congress, will be next summer. Certain NASA spokesmen said this week, however, that the space agency's launching schedule may be revised so that another *Echo* sphere can be launched later this year.

The first attempt to launch *Echo* flopped when the second-stage attitude control jets failed to function.

The failure came after more than 10 frustrating days on the launch pad. Problems with the first- and second-stage guidance systems of the *Thor Delta* launching vehicle thwarted earlier attempts to place the 100-ft.-diameter inflatable sphere into orbit.

Purpose of the experiment was to place the large sphere into a 1000-mile circular orbit where ground stations could bounce signals between the East and West Coasts in communications experiments.

The first and second stages of the three-stage *Delta* vehicle apparently performed as planned. Telemetry data indicated that about halfway through the vehicle's coast period the attitude control jets in the second stage failed.

• **Sphere's composition**—The sphere to have been orbited was made of 82 separate flat gores of DuPont Myler Polyester film by the G. T. Schjeldahl Co. The shell was covered with vapor-deposited aluminum to provide radio wave reflectivity of 98%, up to frequencies of 20,000 mc.

Before launching, about 30 lbs. of sublimating powders were inserted in the sphere. It was then folded accordian-fashion and placed inside a 26½-in.-diameter magnesium container made by Kaiser-Fleetwings, Inc.

The satellite carried no instrumentation. Had the satellite been placed in orbit, its position would have been determined by the telemetry signals emanating from the third stage. These signals would also have revealed the instant of payload separation.

About two minutes after the payload would have been injected into orbit, the magnesium container was designed to have been split open by an explosive charged placed around its middle. After release from the container, the sphere would begin to inflate with the 10 lbs. of benzoid acid plus 20 lbs. of anthraquinone.

• **Experiment plans**—The two primary stations to have taken part in the experiment were NASA-JPL's Goldstone station in California and Bell Telephone Laboratories' facility at Holmdel, N.J.

During the experiment, BTL would have transmitted on a frequency of 960 mc/s for reception at Goldstone. JPL would have transmitted at 2390 mc/s to BTL. The NASA Goddard Space Flight Computing Center would have sent orbital calculations to both stations.

To set up the communication link, BTL would have illuminated the sphere with a 960 mc/s signal. This signal would have bounced off the satellite in all directions. A portion of the scattered energy would have been picked up by the Goldstone station where the receiver is pointed toward the satellite. To complete the communication link, Goldstone would have transmitted in the same manner at 2390 mc/s for reception at BTL. Transmitted power would have averaged about 10 kw.

• **Launch vehicle**—The first launch attempt of the *Delta* vehicle, though a failure, came just a little more than a year after NASA signed a contract with Douglas for its development.

The *Thor*-based vehicle stands 92 ft. high and has a maximum diameter of 8 ft. Its fueled weight is a little less than 112,000 lbs.

Similar in configuration to the *Thor-Able*, the *Delta* features an improved autopilot and radio guidance system for the first- and second-stage powered flight and precise attitude control for a longer coast period between second-stage burnout and third-stage ignition.

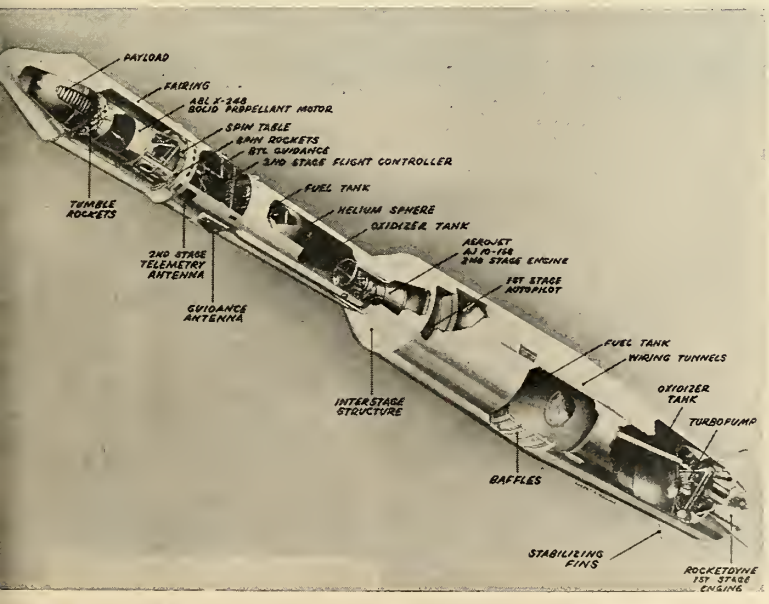
In the firing sequence, the Douglas SM-75 *Thor* first stage provides about 160 seconds of powered flight during which the rocket is guided by BTL's guidance system and roll and pitch programers.

The second stage Aerojet-General AJ10-118 engine ignites almost immediately after first stage cut-off. The 4000-lb., 7500-lb.-thrust vehicle burns for 20 seconds while the nose fairing protecting the payload and third stage jettisons. Then it fires for about 115 seconds while being steered by the BTL guidance system.

With the second stage still attached, the vehicle coasts for about 15 minutes until the vehicle is about 800 miles high and 2300 miles down range. Its attitude is controlled by the jets which failed to ignite in last week's firing.

After coast, in rapid sequence, the Allegany Ballistics Laboratory ABL-248 third stage is spunup to 120 rpm by small spin rockets to stabilize its flight. The third stage ignites, and the second stage is separated by explosive bolts. The 500-lb., 3000-lb.-thrust third stage burns for about 40 seconds.

After third-stage burnout, de-spin rockets slow the rotation. The empty third-staging casing, weight about 50 lbs., is separated from the payload by a spring which retards its velocity and is tumbled by a lateral rocket so that it will not interfere with the payload.



ASW engineering

Drones to Explore Ocean Bottom Down to Five Miles

A helicopter-type rotor appendage will be "flying" drone bathyscapes over sea bottoms up to five miles deep where the craft will be seeking scientific finds, according to the Office of Naval Research (ONR) and Hughes Aircraft Co.

The "flying" version of the bathyscape is to be a follow-on development of an underseas tracked vehicle developed for ONR by the Marine Physical Laboratory of Scripps Institution of Oceanography, La Jolla, Calif. The engineering and design studies of these drones are part of the Navy's RUM (Remote Underwater Manipulator) program.

In its second sea venture, the present drone was successfully demonstrated earlier this month at La Jolla. The device comprised the hull and track assembly of the ONTOS Marine Corps tank, outfitted with a rotating boom and mechanical arm. At the arm's end was a two-pronged mechanical hand, similar to ones seen in radioactive laboratories for handling "hot" products, which would be used for plucking up items from the sea bottom. Another use would be for installing scientific equipment on the sea's floor, and possibly ASW hydrophones.

The vehicle is reportedly able on the ocean bottom to mount foot-high objects, climb a 60% grade, and reach a speed of 3 mph. Four television cameras for observing the sea floor are in the craft. Control signals and electrical power are said to come from a shore-to-vehicle cable and also from a sonic link.

The Hughes-developed lift appendage "will handle an immersed weight up to 8000 pounds, propel it in any direction and stay submerged in salt water for months without damage to its material," according to Dr. John Clark, manager of the company's nuclear electronics laboratory.

To energize the appendage, power from a generator on land is transmitted at high voltage over a coaxial cable to the underwater tracked vehicle. Here, the power is stepped down by transformers. These supply the power needed to drive the appendage's large rotors, which revolve at low speed to create minimum disturbance in the water. Vanes on the appendage control yaw, velocity and position.

review

MAGNESIUM AND ITS ALLOYS, C. Sheldon Roberts, John Wiley & Sons, New York, 230 pp.

The extraction, refining and casting of the metal as well as its physical and chemical properties, alone and alloyed are treated. The work is designed to be an authoritative reference and the duplication of commercial literature has been avoided. In the words of the author, the book is an effort to present the latest scientific properties and technology, to emphasize uncertainties which need to be resolved and a definite relationship between the two.

contracts

NAVY

$1,500,000—Minnesota Mining & Manufacturing Co., St. Paul, for research into high-energy solid-rocket fuels.

$98,854—Develco, Inc., Belmont, Calif., for design and construction of thirty VLF satellite receivers and ground station receivers.

$58,139—Broadview Research Corp., Burlingame, Calif., for research on generation of surface waves.

$50,000—University of Michigan, Ann Arbor, for research on acoustic signal processing.

$49,550—Cleveland Pneumatic Industries, Inc., Washington, D.C., for study of the stability and control of ground effect machines operating in amphibious environments.

$48,846—University of Chicago, for research on the reactions of diazoxides.

$25,000—Melpar, Inc., Watertown, Mass., for research to determine effects of correlation processing.

AIR FORCE

$500,000—Federal Pacific Electric Co., Newark, N.J., for electrical equipment for the *Atlas* installation at Warren AFB.

$486,000—Chance Vought Aeronautics Division, Dallas, for a metal-forming study which will provide a guide to use of the newer metals in defense and space research vehicles.

$290,000—University of Southern California, Los Angeles, for research on "Theoretical-Experimental Studies in Hypersonic Low Density Flow."

$83,988—Electro-Optical Systems, Inc., Pasadena, Calif., for research and development of a molecular tunable amplifier.

$83,205—Rias, Inc., Baltimore, for continuation of research in non-linear mechanics.

$79,915—General Dynamics Corp., San Diego, for continuation of work on "Chemical Reactions using Modulated Atomic and Molecular Beams."

$67,808—Aerojet-General Corp., Azusa, Calif., for continuation of research on "Recombination Processes in Advanced Propulsion Systems."

$59,284—University of North Carolina, Chapel Hill, for research on "Investigation of Imperfections in Ionic Crystalline Solids."

$44,775—Armour Research Foundation of Illinois, Chicago, for study of "Structure of Defect Clusters in Solids."

$43,925—Columbia University, New York City, for research on "Molecular Collision Processes at Low Pressures."

$39,112—University of California, Berkeley, for continuation of research on "Theoretical Study in Nuclear Structure, Nuclear Models and Elementary Particle Interactions."

$31,000—Massachusetts Institute of Technology, Cambridge, for research on "Heat Transfer in a Plasma."

$30,000—Columbia University, for review and evaluation services in the field of solid state sciences.

$28,860—American Institute of Physics Inc., New York City, for continuation of research on "Physics of Fluids Information Exchange."

ARMY

$3,067,568—Chrysler Corp., Detroit, for *Jupiter* missiles (two contracts).

$2,000,000—International Telephone & Telegraph Corp., for building a microwave communication span designed to bridge an ocean expanse of some 500 miles.

$1,178,000—Jas. W. Glover, Ltd., Honolulu, for construction of a dual-Hercules Launches, Sites Nos. 3 and 4, Oahu, Hawaii.

$307,776—Southern Waldrip & Harvick Co., Long Beach, Calif., for construction of an operations auxiliary building.

$143,273—Douglas Aircraft Co., Santa Monica, Calif., for spare parts for the *Nike* System.

$115,885—RCA, for a computer study in connection with Project Press.

$110,436—Dynatronics, Inc., Orlando, Fla., for services and materials necessary to design, develop, fabricate and deliver to the Government camera timing equipment for use in Ballistic Missile Systems, Supplement.

$98,872—Martin Construction Co., Cocoa Beach, Fla., for construction of a maintenance building for technical instrumentation in connection with the Azusa tracking system.

$62,000—Hayes Aircraft Corp., Birmingham, for engineering design, fabrication, modification, and re-work, ground services equipment, *Saturn*, Supplement.

$38,500—Firestone Tire & Rubber Co., Los Angeles, for spare parts for *Corporal* Missile System.

MISCELLANEOUS

Transco Products, Inc., Los Angeles, received a contract from Boeing Airplane Co. for the design and manufacture of a 30 KW, K-band delay line with a choice of delay time remotely controlled for use with a ground check-out system.

Western Scientific Instrument Co. has been awarded a contract for programed maintenance, repair and calibration of vital laboratory test equipment in the La Jolla plant of the Control Systems Division of Daystrom, Inc.

Allison Div., General Motors Corp., received a contract from Atomic Energy Commission to begin preliminary design and development of a compact nuclear powerplant for military applications.

Ryan Aeronautical Co. has received a contract with Watertown Arsenal under which Ryan engineers will conduct experiments in explosive forming of standard and "exotic" metals.

$120,000—P. I. Steel Corp., Los Angeles, for construction of a missile fuel processing building.

NASA

$303,000—Hermes Electronics Co., Cambridge, Mass., for master timing and countdown systems to be installed at Wallops Island, Va.

$300,000—J. W. Fecker Division of American Optical Co., for installation of a long-focal-length tracking facility with specially designed and rotating telescope shelter tower at Wallops Island, Va.

British, Aussies Doubt Value of Man in Space

MELBOURNE—Three leading British and Australian scientists have agreed that American and Russian plans to shoot men into space were political stunts rather than scientific research.

Sir Harrie Massey, Australian-born Chairman of the British National Committee on Space Research, said at the Space Research Symposium of the Australian Academy of Sciences that it was relatively unimportant to put a man into space because instruments in rockets and satellites could supply better scientific observation.

"In his first future flights the spaceman will be concentrating only on the button which will send him back to earth," he added.

"Man in space does not seem a very good way to do scientific experiments. The justification for putting a man into space must be based on other grounds. The United Kingdom Space Programme does not provide for putting a man into space, but this is a vital part of the Russian and American programmes."

• **Long view**—Massey said the United Kingdom had the advantage of a good launching range at Woomera. The United Kingdom Space Research Programme was considerable, he pointed out, involving plans for one launching a month.

"This sort of work is not the kind which can be completed in a few years. There is no limit to the amount of study which can be profitable in the scientific sense," he said.

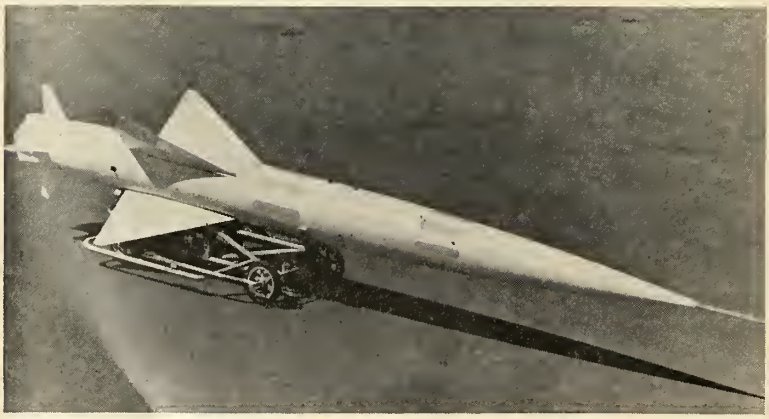
"The issue of whether the United Kingdom will engage in satellite shots is still being considered. It is something which has been actively considered and is getting very close to the final stages of decision."

Sir Harrie said that late next year the U.S. would launch a satellite in America carrying British instruments. Six to nine months later a similar cooperative launching would be made and a third was planned for a later date.

• **No strain**—The head of the Upper Atmosphere Section of the Commonwealth Scientific and Industrial Research Organisation, Dr. D. F. Martyn, said instruments put into space could provide much better information than a man because they did not suffer the strain, psychological and otherwise, that a man would undergo. There were enormous difficulties in space travel projects which had doubtful benefits except scientific. He did not believe there would be commercial space travel of people to the moon or the planets during our lifetime. However, America or Russia would probably place a man in orbit round the earth within a year or two.

The President of the Academy, Sir John Eccles, described the man-in-space project as being a kind of political demonstration rather than a scientific experiment.

Swiss Bird Widely Tested



SWITZERLAND'S RSD-58 has been tested in the United States, Italy and Japan. 19.7 ft. long, the missile develops 2200 lbs. of thrust, with a maximum range of 20 miles. It was developed by Oerlikon Co. and its electronic subdivision, Contraves.

Farnborough Show Slated To Be One-third Larger

The missile exhibit area at the British Farnborough Air Show this year will be about a third larger than last year's. Staged by the Society of British Aircraft Constructors, the Show will be held from September 5 to 11.

Although the floor space of the main building will be the same as in 1959, the actual stand space, including the equipment display, will be larger than ever before. Equipment manufacturers will get an increase of about a third; missile, airframe and engine manufacturers will be allotted an extra 8000 square feet.

The two big missile and aircraft manufacturing groups, Hawker Siddeley and British Aircraft Corporation, will each have consolidated stands covering 7500 sq. ft., while Westland, the helicopter group, will have 2000 sq. ft. The total, 17,000 sq. ft., will be 7000 sq. ft. more than the companies which comprise the new groups had last year. The main powerplant companies, Bristol Siddeley and Rolls-Royce, will each have 2000 sq. ft., the total of 4000 sq. ft., being 1000 sq. ft. more than in 1959.

French Now Probing Upper Atmosphere with Veronique

Biological and geophysical upper atmosphere test probes using *Veronique* rockets are being carried out by the Comité d'Action Scientifique de la Défense Nationale at Colomb-Bechar and Kerguelan Island test ranges.

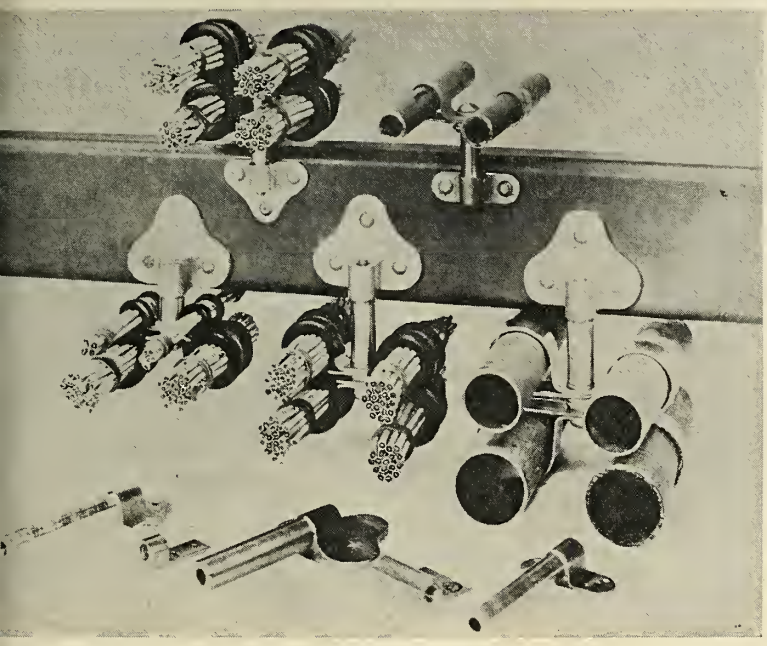
Mice, carried in the rocket's nose cone and parachuted back to earth, will be used for the biological studies.

Veronique is now considered reliable. During early testing, only four complete successes were obtained out of 15 launchings; but since scientific experiments have begun, reliability has been in the ratio of two successes for three launchings. An advanced version of the *Veronique* will permit investigation up to about 435 miles.

Two-Stage Skylark Rocket Launched at Woomera

A two-stage *Skylark* research rocket recently launched at Woomera reached a height of 136 miles. Single-stage versions of the rocket have reached about 100 miles.

In making the announcement, R. L. Cartwright, Principal Scientific Officer of the Weapons Research Establishment, said it was hoped higher shots would be made with two-stage *Skylarks* when the second-stage engine was more fully developed.



Screw Lock Inserts Cut Costs

Supports for securing electrical wiring bundles, hydraulic tubing, plumbing lines and heater ducts in aircraft and missiles have been improved and installation costs reduced by 30% with Western Sky Industries' self-locking fasteners incorporating Heli-Coil (R) Screw-Lock inserts. WSI locking brackets reduce space requirements and increase rigidity and vibration resistance in aircraft and missiles.

WSI forged aluminum single and double fasteners are available in various lengths in increments of 0.1 in. The new fasteners replace combinations of nut plates, tube spacers and attachment lugs and do not require a clearance hole that penetrates and weakens the structural member. This type is also used in missile packaging, with or without shock absorbers, to attach delicate equipment to mounting plates which in turn are attached to the packing case. These cases must withstand high impact loads.

Circle No. 225 on Subscriber Service Card.

Electron Beam Furnace

A production-type electron beam furnace capable of alloying and refining ingots up to diameters of 4 in. and lengths of 14 in. has been developed by NRC Equipment Corp., Newton, Mass.

Designed for use by trained technicians as well as research scientists, the furnace operates in a vacuum of 10^{-6} mm Hg. Exceptionally pure ingots of tantalum, molybdenum, niobium, tungsten, cobalt, thorium, nickel and hafnium are easily produced without danger of contamination from electrodes or crucibles.

Model 2460 is divided into two separate chambers—one containing the electron gun and the other the mold and feeding mechanism. Each has a pumping system. The electron gun is protected from gas bursts by the separating shield.

The melting rate can be varied over a wide range, exposing the melt to a high vacuum for as long as desired. The main power supply delivers up to 3 amps at voltages up to 20,000.

Circle No. 226 on Subscriber Service Card.

Damping Compound Spray

A viscoelastic material which, when sprayed or trowelled onto metal plate, drastically reduces structurally borne noise and vibration has been announced by The Korfund Company, Inc.

Designated Korfund VIBRODAMPER compound, this damping material solves the problems of noise transmitted along structural paths thru sheet metal, and of the drumming noise created by vibration or thermal movements of metal plates.

VIBRODAMPER compound is handled like paint, dries to a smooth, attractive finish, is non-toxic and nonflammable. It is resistant to alkali, grease, gasoline, and aliphatic oils, and is unaffected by ozone or sunlight. It has an extremely long effective life, and does not become brittle or change in any way with age.

Circle No. 227 on Subscriber Service Card.

Rejection Circuit

Kearfott Division of General Precision Inc., has announced the availability of the D4816-01 quadrature rejection circuit designed to operate from a preamplifier or gain controlled amplifier into a transistor servo amplifier.

Small and lightweight, this device rejects the component of the input wave which is 90° from the reference input. The component of the input sine wave which is in-phase with the reference will produce a square wave whose magnitude is proportional to the load and the magnitude of the in-phase signal.

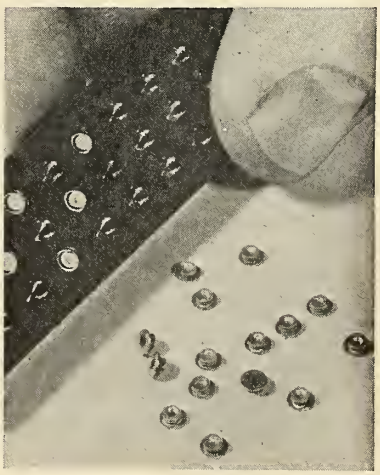
The unit is designed to operate in an ambient temperature range of −55°C to +115°C at altitudes from 0 to 100,000 feet.

Circle No. 228 on Subscriber Service Card.

Four Gigacycle Diodes

A miniaturized tunnel diode capable of oscillating at frequencies in excess of 4 gigacycles, four times the range of previously announced tunnel diodes, has been announced by Sylvania Electric Products, Inc.

The increased frequency range is



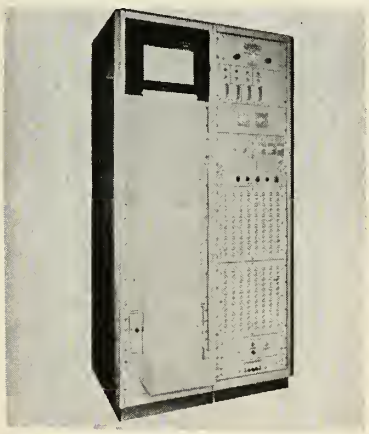
the result of a unique etching process and a low-inductance packaging technique. In addition to a frequency range of 3 kmc, the new tunnel diodes have a peak to valley ratio of 5 to 1, a peak current up to 4 ma, at approximately 50 millivolts, and a minimum current at approximately 350 millivolts.

Circle No. 229 on Subscriber Service Card.

Strain Gage Plotter

Designed for plotting strain or stress tests where loading is fast and data must be acquired rapidly, a new high speed strain gage plotter by Gilmore Industries, Inc. can be used to plot strain gage outputs on pressure vessels, rocket engine casings, and other structures.

The Model 221 scans and records 20 channels per second and plots in multiples of 96 channels. It automatically plots individual graphs for each



channel while the test is in actual progress. There are three zero positions per channel, separate range selectors, and separate gage factor selectors.

Switching is accomplished by heavy-duty large contact, low noise rotary type multi-deck switches. Positive gearing to chart drive insures synchronization between the chart graphs and their particular input channels.

Circle No. 230 on Subscriber Service Card.

Freeze-Free Transducer

An electro-pneumatic transducer that permits a pneumatic valve actuator to be used with an electronic control system has been designed by the Swartwout Division of the Crane Co. to eliminate freeze-ups caused by cold weather or low-temperature fluids.

The Type P2R Power Relay contains a 30 watt heater in the pneumatic section that prevents moisture in the air from freezing the mechanism.

It is a null-balance unit that contains no vacuum tubes, journal bearings, or other friction surfaces. A magnetic force is opposed by an air-loading pressure to produce a pneumatic force linearly proportional to the electrical output of the controller. The unit is temperature compensated to maintain its calibration accuracy over a wide range of ambient temperatures.

Circle No. 231 on Subscriber Service Card.

Multiple Throw Switches

A line of single-pole multiple-throw solid-state (crystal) microwave switches has been developed at American Electronic Laboratories, Inc. In addition to the single-pole ten-throw unit, A.E.L. has built double-throw and four-throw switches. These switches are generally characterized by their rapid switching time—less than 10 millimicroseconds—low insertion loss when "on" coupled with high "off" attenuation, broad RF bandwidth and the small amount of switching power required.

Units are available in various frequency ranges from 10 mc to 10,000 mc.

Circle No. 232 on Subscriber Service Card.

new literature

CONFORMAL CASTING. Methods of forming molds for casting resins by vacuum-drawing heated thermoplastic sheets over electrical components are described in an 8-page booklet available from Minnesota Mining and Manufacturing Co. The booklet is complete with photographs which demonstrate the vacuum forming process. A section is devoted to a discussion of materials and equipment required for developmental study.

Circle No. 200 on Subscribers Service Card.

SMALL TUBING GUIDE. A revised edition has been published by Superior Tube Company. The 12-page bulletin—designed for fast, easy selection of tubing for any given application—briefly summarizes the significant properties of 84 tubing analyses in seven groups: carbon steels, stainless steels, alloy steels, nickel and nickel alloys, copper-base alloys, glass sealing alloys and reactive metals. Each alloy is described in an easy-to-read tabular style which provides the AISI type number, available form (seamless or weldrawn), characteristics, and applications. Also included are concise descriptions of 13 specialty tubing products: hypodermic needle, capillary, super-pressure, aircraft hydraulic, miniature heat exchanger, large OD thin wall, superalloy, diesel fuel injection, carbon mechanical, SAE carbon hydraulic, tool steel, Bourdon, and thermocouple tubing.

Circle No. 201 on Subscriber Service Card.

SLIP RING ASSEMBLIES. A 28-page catalog available from Breeze Corporations, Inc., describes its line of seven standard slip ring assemblies for general purpose control and power, high voltage, radio frequency and video, switching and high-speed instrumentation. The catalog includes specifications and drawings of all the standard assemblies and photos and operating data on the custom units. In addition, there is illustrative and descriptive material on flat, cylindrical and concentric assemblies and a section on the manufacture of fabricated, plated and molded slip ring assemblies, ring materials and brushes.

Circle No. 202 on Subscriber Service Card.

HERMETIC SEALS. Catalog 1259, listing basic types of precision hermetic seals which are regularly available for evacuated or pressurized enclosures, has been published by Dage Electric. Each type of seal is clearly illustrated and listings give complete dimensional specifications. A special section gives latest accepted glass seal nomenclature. To assist the designer who requires custom-made seals, the 28-page catalog also covers general manufacturing techniques and usage recommendations. Dage precision hermetic seals are tested to insure unit integrity with respect to moisture, corrosion, extreme pressures, vibration and rare atmospheres.

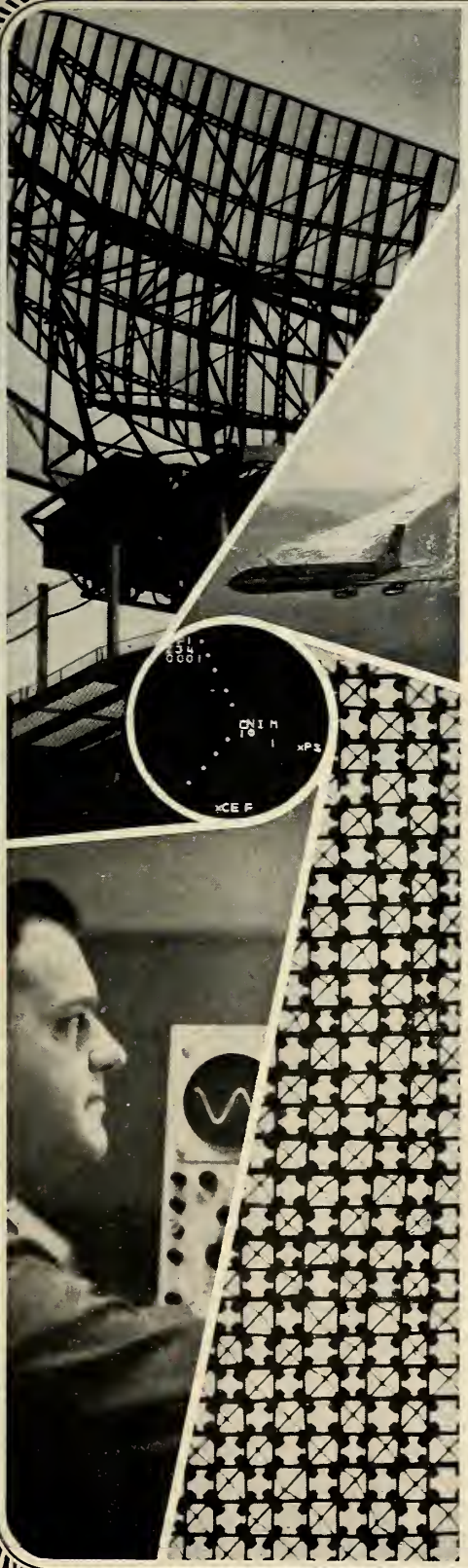
Circle No. 203 on Subscriber Service Card.

CLEVELAND AERO-SPACE ASSOCIATION, INC.—A brochure describing the capabilities of a group of industrial firms in the Cleveland area with many years of successful subcontracting experience in the missile, aircraft and general ordnance fields. Members are heavy investors in research and development facilities. Some of the areas include flight propulsion, missile fuels, chemicals, atomic energy and metallurgy.

Circle No. 204 on Subscriber Service Card.

WHICH WELDING PROCESS FOR THE NEW METALS? Authored by I. D. Holster, applications engineer, Air Reduction Sales Company, the brochure offers a comprehensive review of the problems involved in joining the new metals and alloys used in aircraft and missile design such as: PH stainless steels, ultra-strength steels, rene 41, beryllium, zirconium, molybdenum, tantalum and columbium. The article also contains tabular presentation of process data on four of these new metals.

Circle No. 205 on Subscriber Service Card.



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Bastian (Buzz) Hello: Former P5M and miscellaneous programs manager for The Martin Co.'s Baltimore Division, named program manager for the rocket booster portion of the Air Force *Dyna-Soar* project. **William A. Bortner,** operations planning manager since 1957, replaces Hello in his former position.


HELLO

C. B. Wilson: Elected vice president-program development for Applied Science, Inc. Was formerly corporate systems engineer for Fairchild Engine and Aircraft Corp.

Jean R. Nelson: Former project engineer with Minneapolis-Honeywell Co.'s Aeronautical Division, named director of engineering for Winzen Research, Inc., responsible for efforts in the design and construction of manned balloon/sealed cabin systems for scientific research in the stratosphere.

Gerald Lewis: Director of product engineering for Cooper Alloy Corp., appointed director of product development responsible for the development and introductory marketing.

Arthur P. Notchoff, Jr.: Former manager of Serva Engineering in Dalmo Victor's Engineering Division, named manager of engineering of the Electronic Systems Division.

Kenneth H. Hobbie: Promoted to director of marketing for the Driver-Harris Co. **W. P. Smith** succeeds Hobbie as sales manager.

Harold W. Gear: Elected manager of Operations Analysis within Atlantic Research, Inc.'s Solid Propellant Division. **Roger N. Saleeby, Jr.,** succeeds Gear as plant manager of the Pine Ridge facility.

Robert Beltz: Developer of the transistorized voltage tolerance supply for the *Falcon* missile and of components for the telemetry of the *Atlas* and *Thor*, joins the Jordan Electronics Division of The Victoreen Instrument Co. Was formerly staff engineer at Hughes Aircraft Co.


BELTZ

William C. Adams: Joins Lockheed Electronics Co. as manager of the Computer Systems Division of Information Technology. Previously served in various technical and scientific positions including six years at Edwards AFB.

Marvin E. Groll: Named product sales manager-microwave diodes, for the Semiconductor Division of Sylvania Electric Products, Inc., replacing **R. A. Swanson,** named product sales manager-transistors.

Robert O. Vaughan: Named vice president-marketing at Southwestern Industrial Electronics Co., with **Thomas M. Lynch** as marketing manager, Heavy Military Electronics. **S. Field Emerson** promoted to marketing manager, Light Military Electronics.

David Fox: Elected director of the Computer Division of the Systems Research Group, Inc.

John J. Giba: With American Bosch Arma Corp., since 1932, appointed manager of the firm's Tele-Dynamics Division.

Othmar W. Sailer: Former manager of product planning for Wiancko Engineering Co., named director of marketing for the Unitek Corp.

Jack L. Bowers: Named to the newly created position of vice president, Electronics Systems and Equipment Operation, Crosley Division, Avco Corp., responsible for engineering, marketing, production and administration. Was formerly assistant chief engineer-design for Convair Astronautics.


BOWERS

Kearfott Division of General Precision, appoints: **Walter J. Krupick,** general manager, Gyrodynamics; **William Supina,** manager and chief engineer of the Precision Gyro Dept., Gyrodynamics, and **John J. Daly,** manager and chief engineer of the Gyro Reference Dept., Gyrodynamics.

John F. Hegarty: Elected vice president-marketing of National Semiconductor Corp. Was formerly marketing manager.

Bruce McKay: Formerly general products manager, Vertol Division of Boeing Aircraft, appointed assistant vice president-marketing for Bell Aircraft Corp.'s Niagara Frontier Division.

Dr. James N. Waggoner: Medical director for The Garrett Corp.'s AiResearch Manufacturing Co., elected a Fellow of the Aerospace Medical Association. He has been assisting in the development of the environmental control system for NASA's Project *Mercury* and is one of nine chosen for his outstanding contribution to the aerospace medical field.

Donald F. Davern: Former manager of planning at Hughes Aircraft Co.'s Tucson missile manufacturing plant, named project manager of industrial control systems,

James R. Wescott: Appointed to the newly-created position of vice president-marketing for the Gabriel Electronics Division of The Gabriel Co. For the past five years was marketing manager of the Heavy Military Division of General Electric Co.


WESCOTT

William W. Crossman and **Robert J. Martin:** Named, respectively, manager and sales manager of Hitemp, Inc., a newly formed subsidiary of Hitemp Wires, Inc.

Stanley A. Lawrence: Appointed assistant division manager-Special Project for Collins Radio Co.'s Western Division.

Ted J. Gordon: Named project engineer of Douglas Aircraft Co.'s *Saturn* second-stage program at Cape Canaveral. **Hal M. Thomas** appointed manager of the project. Gordon was previously project engineer for the *Thor-Able* space vehicle program and the *Delta* space probe and satellite launchings. Thomas was program manager of the *Thor* IRBM.

George D. Clark: Appointed manager of RCA's missile test project at the Air Force Missile Test Center, succeeding **K. M. McLaren,** who recently resigned as vice president, MTP.

Dr. James M. Carter: Recently corporate research advisor for Aerojet General Corp., appointed director of the Physical Sciences Division of Space Systems Laboratories.

Dr. Alan G. Stanley: Advanced to assistant director of research at General Transistor Corp.

James R. Corcoran, Jr.: Former president and treasurer of Topic, Inc., appointed assistant to the vice president of the Ogden Division of The Marquardt Corp.

Alan R. Stearns: Former partner and general manager of the Stearns Co., elected manager, special projects, for Marshall Industries.

Harold A. Price: Named manager, industrial products division of Horkey-Moore Associates. Was formerly manager of the Permanent Filter Corp.'s Lafayette and Long Beach Divisions.

Donald A. Cook: Appointed director of the Transducer Division of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

when and where

MAY

National Telemetering Conference, Miramar Hotel, Santa Monica, Calif., May 23-25.

Tappi Coating Conference, Eleventh Annual, Edgewater Beach Hotel, Chicago, May 23-25.

German Society for Rocket Engineering and Space Flight, 12th Annual Meeting, Research, Heidelberg, West Germany, May 23-25.

ASME Design Engineering Conference & Show, Statler Hilton Hotel, New York City, May 23-26.

14th Annual Armed Forces Communications and Electronics Association Convention, Sheraton-Park Hotel, Washington, D.C., May 24-26.

American Society for Quality Control, Annual Convention, Sheraton-Palace Hotel, San Francisco, May 24-26.

Japanese Rocket Society, Second International Symposium on Rocketry and Astronautics, University Club in Tokyo, May 24-28.

IAS Specialists Meeting, Guidance of Aerospace Vehicles, Hotel Somerset, Boston, May 25-27.

The Psychophysiological Aspects of Space Flight, sponsored by the School of Aviation Medicine, ATC, Aerospace Medical Center, Southwest Research Institute, San Antonio, May 26-27.

Society of Naval Architects and Marine Engineers, Spring Meeting, Statler Hotel, Washington, D.C., May 26-28.

Fourth International Symposium on the Reactivity of Solids, Amsterdam, May 30-June 4.

JUNE

Instrument Society of America, Annual Instrumental Methods of Analysis Symposium, Montreal, June 1-3.

Sixth Annual Radar Symposium, University of Michigan, sponsored by Army, Navy, AF, Willow Run Laboratories, Ann Arbor, June 1-3.

Fourth Annual Summer Conference on Vacuum Metallurgy, New York University's College of Engineering, NYU's University Heights Campus, Bronx, N.Y., June 2-3.

ASME Summer Annual Meeting and Aviation Conference, Statler Hilton Hotel, Dallas, June 5-9.

Society of Automotive Engineers, Summer Meeting, Edgewater Beach Hotel, Chicago, June 5-10.

Machinability Seminar, Pennsylvania State University, University Park, June 6-10.

National Society of Professional Engineers, Annual Meeting, Statler Hotel, Boston, June 8-11.

American Nuclear Society, National Meeting, Palmer House, Chicago, June 12-14.

American Institute of Mining, Metallurgical and Petroleum Engineers, International Powder Metallurgy Conference, Biltmore Hotel, New York City, June 12-15.

Seminar in Design Engineering, Pennsylvania State University, University Park, June 12-17.

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editorial . . .

Space Act Revision—Well Done

Two years ago, in an atmosphere of startled concern over Russian achievements in space, Congress passed the National Space Act. It was hastily-drawn legislation and not the best.

The House Space Committee has now reported out a reorganizational bill (HR 12049). It is an excellent measure. It corrects the major faults of the original. It deserves to pass the House and to be sent to the Senate Space Committee without deviation so that final action can be accomplished at this session of Congress.

The new measure eliminates many of the undesirable features of the old bill, adds certain necessary clauses and clarifies roles and missions in the space field. Specifically, it:

Relieves the President of a rather ridiculous role as project officer for space projects.

Abolishes the President's National Space Council and substitutes a DOD-NASA board co-chairmanned by NASA's Deputy Administrator and DOD's Director of Research and Engineering.

Eliminates the Civilian-Military Liaison Committee.

Gives the military a positive role in space.

Strengthens NASA's peaceful role in space.

Pulls NASA's patent authority into line with that of the military.

Provides machinery to indemnify contractors against unusually hazardous risks.

The first three listed changes are purely administrative. Making the President personally responsible for planning and surveying the nation's space needs had placed upon him an impracticable burden, which will now be removed. Elimination of the Space Council follows logically; its chief function was to advise the President on the detailed work he is no longer responsible for —and really never did anyhow.

The Civilian-Military Liaison Committee never functioned, either, for a number of reasons. The new measure insures coordination and cooperation betwecn NASA and DOD at all levels.

Giving the military a positive role in space was a much-needed step. We pursue peaceful exploration of space with the very best intentions, but it is easy to foresee that a time may come when we shall have to fight to be allowed to conduct this exploration. Certainly the military must be prepared to see that no other nation denies us the right to operate in space.

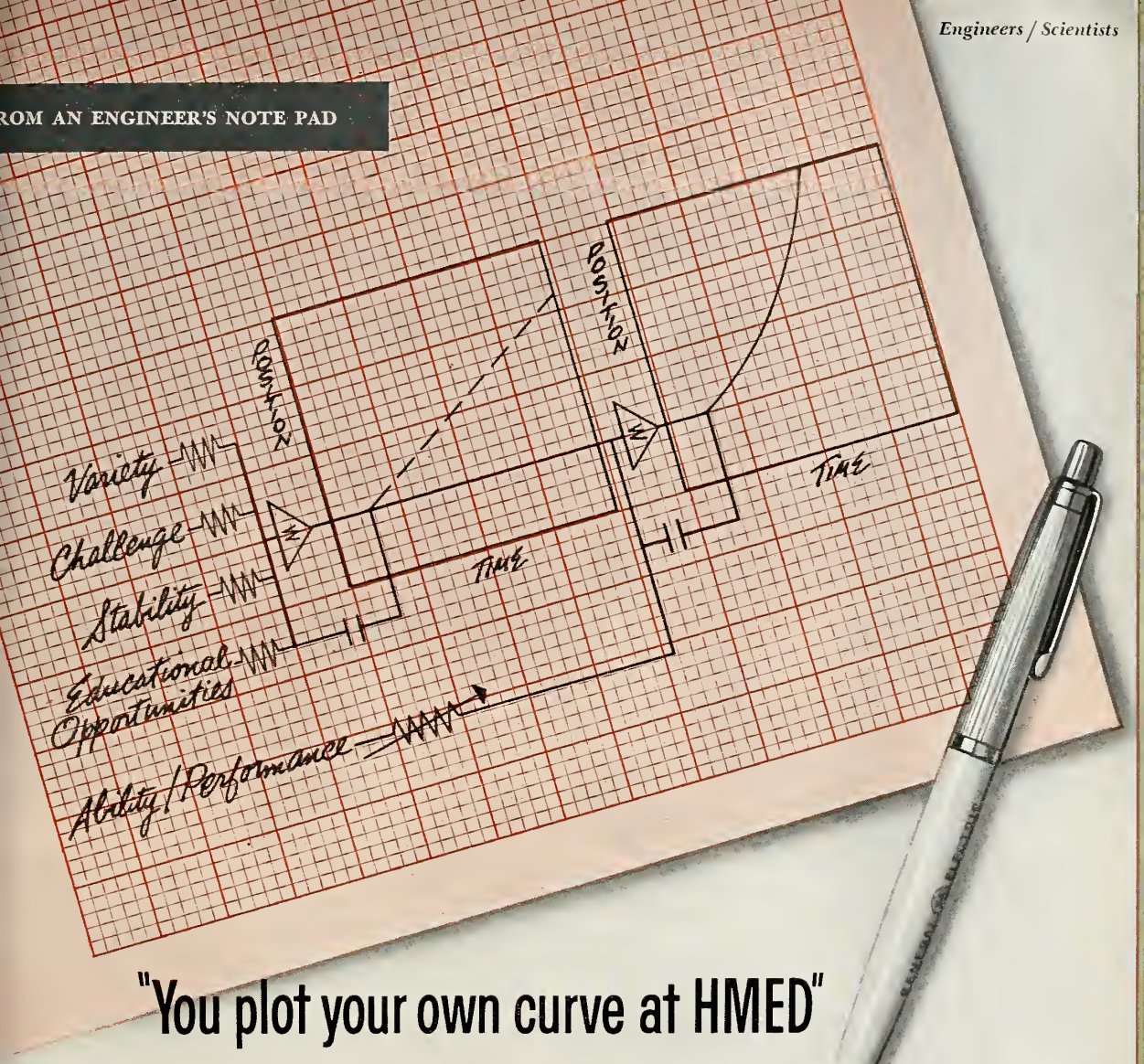
The role of NASA is strengthened by giving the agency a clear responsibility for planning and directing civilian space activities for peaceful purposes. Thus it gives the NASA administrator many of the executive duties heretofore incumbent upon the President. If there is a dispute between NASA and the Services, then the President must arbitrate.

As previous Congresses have done, the Subcommittee concluded that the interests of the government and national economy are best served by allowing a contractor to retain the rights to a scientific invention. The reason is, of course, primarily incentive—specifically because many space research programs generate commercial applications. Without patent protection the manufacturer has little incentive to develop for the commercial market. Under the revised law, the government has rights to the invention for its own use but permits the inventor to retain commercial rights.

The addition of indemnification is just common sense. In dealing with potentially hazardous space powerplants, no contractor can be or should be exposed to the enormous financial risks which might incur through an accident—risks so large that it is impossible to obtain insurance against them. The new bill provides protection.

Few would claim that HR 12049 is the perfect solution. But it certainly is a great improvement over its predecessor, and it appears to provide a workable law. We urge the fastest possible action in both houses of Congress on this imperative piece of legislation.

Clarke Newlon



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Circuit engineers will have little trouble in reading it. Others may have more difficulty. All may wish additional detail. For this, as well as other information regarding the unusual professional and outstanding personal opportunities awaiting you at General Electric's Heavy Military Electronics Department, write in confidence to George B. Callender.

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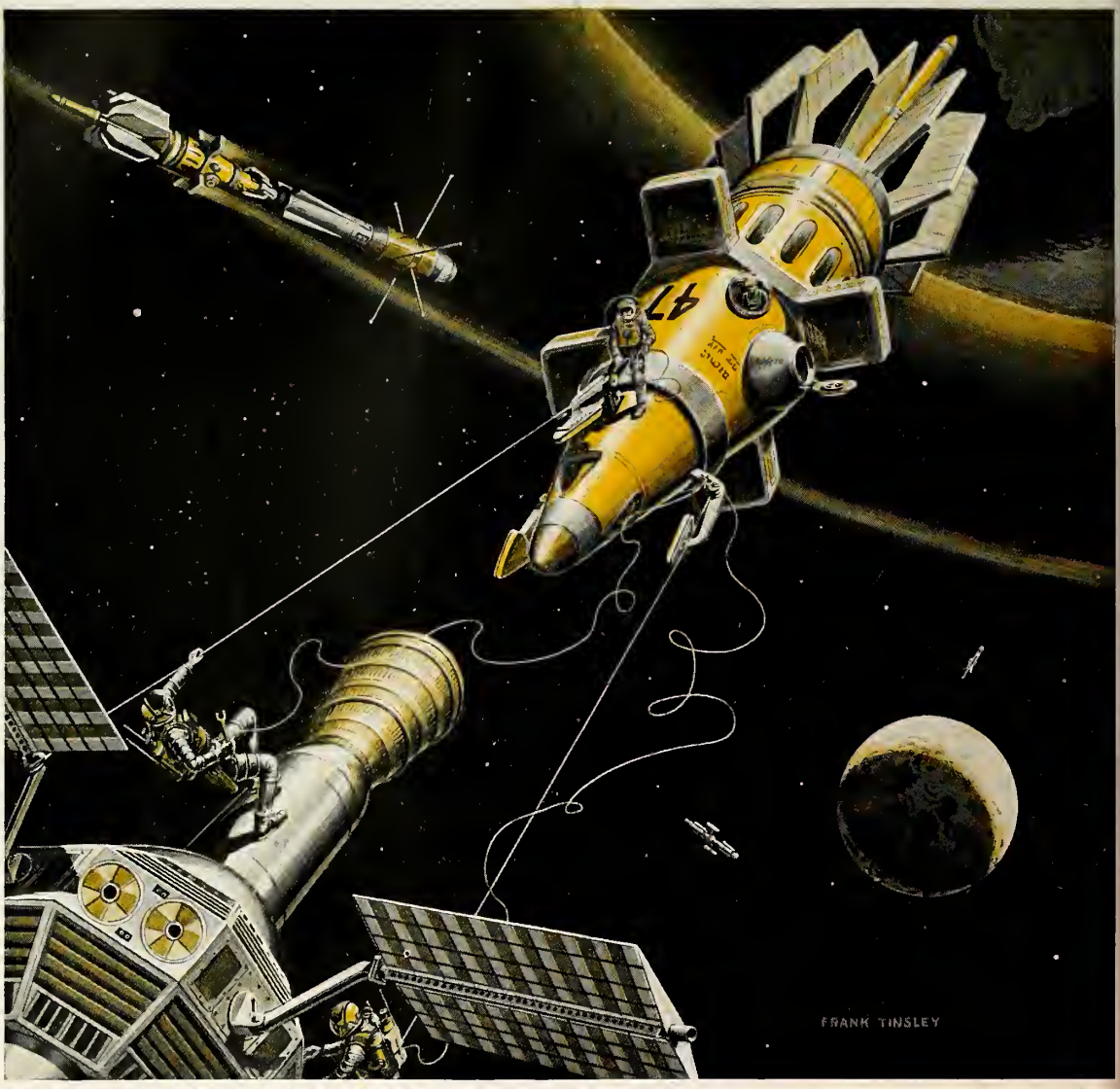

STEPS IN THE RACE TO OUTER SPACE

Breaking a Space Traffic Jam

By 1970 our solar system will be filled with expended satellites—whirling aimlessly in space with dead batteries and electronic equipment, their missions long since completed.

As space traffic increases, these derelicts will have to be captured and broken out of orbit to keep flight paths clear. For this task, special towboats will be designed and crews trained.

Here, step by step, is an account of such satellite capture and destruction:

1. The towboat, driven by electro-particle propulsion, rockets into space at speeds reaching 25,000 m.p.h. Its reversible engines enable it to slow as it approaches the radar-located satellite, and match the derelict's speed as it moves into orbit behind it.

2. Crewmen attach lines to the satellite (as in illustration). Then they haul the towboat forward and its nose cone is clamped to the satellite's rocket nozzle.

3. The towboat's engines are then switched to full reverse and the linked machines gradually lose momentum, nosing into a spiral path toward the Earth below.

4. When a safe point is reached, the towboat automatically releases the satellite and it is consumed by friction as it plunges into the heavier atmosphere. The towboat, regaining its speed, moves on to its next assignment—breaking a traffic jam in some other congested point in space.

ARMA, now providing the inertial guidance system for the ATLAS ICBM and engaged in advanced research and development, is in the vanguard of the race to outer space. For this effort, ***ARMA*** needs scientists and engineers experienced in astronautics. ***ARMA***, Garden City, New York. A Division of American Bosch Arma Corporation.

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